ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 58. No. 18. 220 Broadway, New York, October 31, 1907.

TABLE OF CONTENTS.

Page.

LEADING ARTICLES:
- The Detroit River Tunnel (illustrated) 453
- The Sturtevant Steam Turbine (illustrated) 455
- A New Machine for Handling Coal, etc., Into and Out of Storage (illustrated) .. 456
- The Russell Sage Laboratory; Rensselaer Polytechnic Institute 456
- New Apparatus for the Sterilization of Drinking Water by Heat (illustrated) .. 457
- Annual Convention of the Association of Railway Superintendents of Bridges and Buildings 460
- A Structural Steel Truck Bolster Without Load Stresses on the Rivets (illustrated) 461
- Report of the Transvaal Commission on the Use of Winding Ropes, Safety Catches and Appliances in Mine Shafts (illustrated) 462
- The Twelfth General Meeting of the American Electrochemical Society 465
- The Use of the T-Rail for Street Railway Track in Cities (illustrated); C. G. Reel 466
- Municipal Readjustments of Lot Boundaries on New Streets, Frankfort-on-the-Main 466
- The Prevention of the Short-Stroking of Direct-Acting Duplex Pumping Engines; A. P. Blackstead 467
- A New Zealand Method of Sewage Treatment for Isolated Buildings (illustrated) John Mitchell 467
- Theodore Cooper on the Quebec Bridge and Its Failure 473
- The Organization of the American Peat Society 477

Page.

EDITORIAL 469
- The Panama Canal Locks—Safe Practice in Mine Hoisting—Theodore Cooper on the Quebec Bridge Disaster—Peat as a Fuel—The Financial Situation—More Agitation for Federal Improvement of Waterways—Completion of the Hennepin Canal—Street Car Subways for Congested Traffic Districts—Concerning Edison's Concrete Houses.
- City Planning and Replanning 470

LETTERS TO THE EDITOR 471
- Disjointing Cast-Iron Water Mains with a Gasoline Torch; A. M. Martin—Typhoid Fever at a State Insane Hospital, Trenton, N. J.; Permanganate of Potassium Unsuitable for Detecting Sewer Leaks; W. P. Mason—Balanced Gate Valves at the Wachusett Dam; J. H. Gregory—Disintegration of Concrete Exposed to Sea Water Between High and Low Tides; Wm. B. Mackenzie—More Concerning Municipal Ownership; C. E. Gillette—Notes and Queries.

ENGINEERING NEWS OF THE WEEK 479

PERSONALS 480

ENGINEERING SOCIETIES 480

THE DETROIT RIVER TUNNEL.

One of the most novel and interesting tunnel works now in progress is that of the Michigan Central R. R. tunnel under the Detroit River, to effect a direct connection with its Canadian lines and to avoid the present delay and inconvenience of the car-ferry service for transferring trains across the river. The general plans of this were described and illustrated in our issue of Feb. 15, 1906, but important changes have been made in the actual execution of the work.

The work is now well under way, and the recent commencement of the river section makes a description of the work appropriate at this time. The special feature of the work is in the river section, which will be half a mile long. This is being formed by sinking steel shells in a dredged trench (as described below), so that there is no actual tunneling under the river. The river work and the approach tunnels are all in stiff blue clay. This is firm and solid, with few pockets or water seams, as shown by the test borings. It is easily excavated, but requires heavy timbering to resist the pressure upon the shafts and drifts. The contract for the entire work was awarded on Aug. 1, 1906, to the Butler Brothers, Hoff Co., of New York, and is to be completed by June, 1909. The work is being done under the direction of an advisory board of engineers, composed of Messrs. W. J. Wilgus, M. Am. Soc. C. E.; H. A. Carson, M. Am. Soc. C. E., and W. S. Kinnear, M. Am. Soc. C. E. The method of constructing the subaqueous section originated with Mr. Wilgus, and was developed by the advisory board and the contractors. Mr. Carson had employed a similar method (on a much smaller scale) for water pipe and sewer work under the outer harbor at Boston, but with this exception the plan was entirely new.

It must not be confused with that adopted by the Metropolitan Ry. of Paris for crossing under the Seine. In this latter case (which has been compared with the Detroit River work) the tube or tunnel formed a caisson with working chamber beneath the tube. Excavation was carried on as in ordinary caisson work. This was described in the paper above mentioned.

The tunnel and its approaches will be 2½ miles in length, and will probably be in operation in the autumn of 1909. It is being built by the Detroit River Tunnel Co., which is auxiliary to the Michigan Central R. R. Mr. H. B. Ledyard, Chairman of the Board of Directors of the Michigan Central R. R., is Vice-President of the tunnel company, and as such is its financial and executive head. Mr. W. S. Kinnear, M. Am. Soc. C. E., is Chief Engineer; Mr. B. Douglas, M. Am. Soc. C. E., Tunnel Engineer, and Mr. J. C. Mock, Electrical Engineer (in charge of the electric traction and signaling systems).

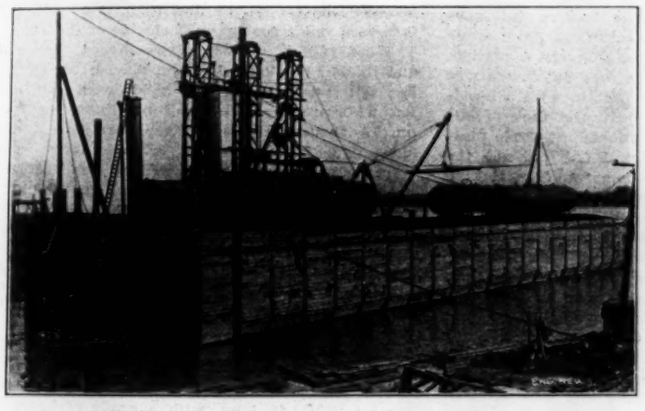


FIG. 1 (1.04 P. M.)

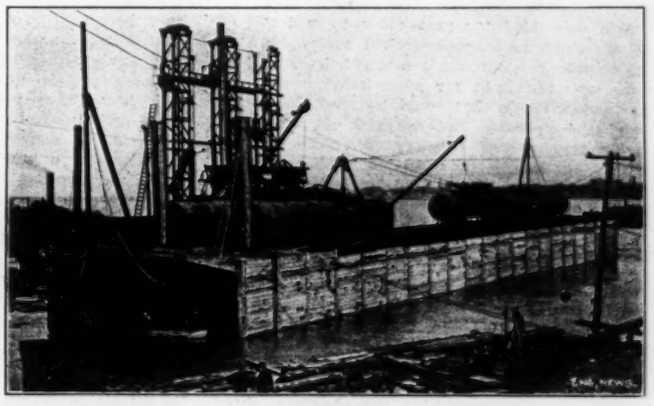


FIG. 2 (3.23 P. M.)

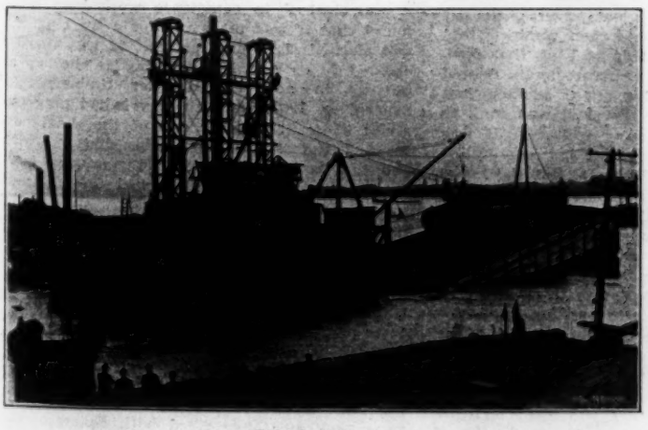


FIG. 3 (4 P. M.)

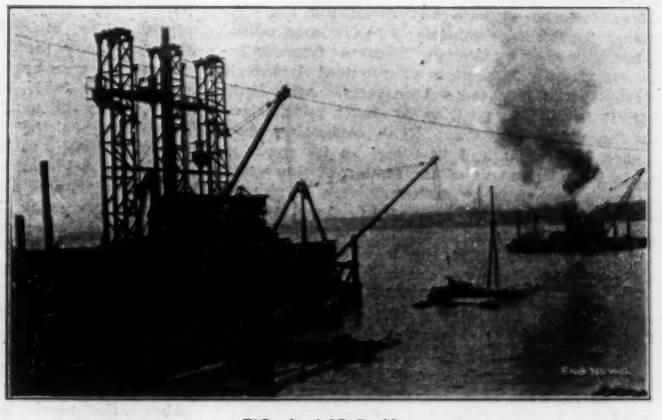


FIG. 4 (4.35 P. M.)

SINKING THE FIRST SECTION OF THE DETROIT RIVER TUNNEL, OCT. 1, 1907.

The river section of the Detroit River tunnel will be 2,620 ft. long between the ends of arch construction from the shore shafts, and is being built on the new and interesting method above noted. In brief, this consists of dredging a trench across the river, and laying a steel and concrete grillage at intervals marking the joining of the tunnel sections. Steel hulls or sections in lengths of about 262 ft. each will then be sunk upon this foundation. Each shell will form a portion of the twin tubes, with the ends temporarily closed by bulkheads. As each is deposited in place, concrete is filled in beneath and around it, and the joints are made as described below. When a few of the sections are in place, some of the bulkheads will be removed, the water pumped out and a 20-in. concrete lining put in each tube, so that in fact the steel shell is simply the form for a massive concrete tunnel. The method was adopted to save time and cost as compared with the usual methods of subaqueous tunneling. The difficulties to be encountered, however, are considerable, especially in view of the depth of water and the constant traffic in the river. The company is authorized by the War Department to obstruct a width of 600 ft. of the channel when required.

The depth of water is about 50 ft. in the main channel, and the trench has to be dredged to a depth of 30 to 50 ft. in the river bed. The bottom width of this trench is about 48 ft., and the side slopes are found to stand well at 1 on 2. The material is a stiff blue clay. A dipper dredge was tried for excavating to a depth of 60 ft. below water, and worked well as far as the actual dredging was concerned, but the machine was not built for such heavy work and the largest spuds that could be used would not stand the pressure and snapped off when the bucket was making a heavy cut. The work is now being done with a dredge having a 60-ft. steel boom carrying a 3-yd. clamshell bucket. This is owned by the Dunbar-Sullivan Dredging Co., of Buffalo, N. Y., which has the subcontract for dredging.

For placing the I-beam grillage, and depositing the concrete of the foundation and enclosing the tubes, a specially large and well equipped working scow has been built by the contractors. The hull is 36 × 154 ft. fitted with heavy spuds. It carries a large double deck or two-story superstructure, above which are screening hoppers for the gravel of the concrete, three complete concrete-mixing plants being installed. The most interesting features are the methods of setting the grillage and depositing the concrete. The grillage consists of heavy longitudinal I-beams with transverse I-beams framed between them. A section of required length is riveted up and floated out on rafts. After sinking, it is held in position by short piles driven to the proper elevation. The concreting scow is floated over it and "set up" on its spuds so as to be independent of the motion of the water. At each corner is an iron rod with turnbuckle connection, and divers connect these to the grillage, the proper elevation and level being obtained by adjusting the turnbuckles. While thus held in place the concrete is deposited by means of tubes or tremies let down from the scow. Along one side of the scow are three towers 75 or 80 ft. high above the water, each with a top platform projecting over the water and carrying a concreting tube 12 ins. diameter and 75 ft. long, with a hopper or funnel at the head.

In depositing concrete for the foundation and for filling in around the tubes, the scow is swung across the work, and held by its spuds. The concreting pipes are then lowered, one at each side and one at the middle (between the two tubes). The concrete is then delivered by hoppers to the funnels at the heads of the pipes, and deposited where required in the bottom of the trench. A gravel concrete is used, in proportions of 1 cement to 3 of sand and 6 of gravel. The mixture is made moderately wet.

The steel shells, as already noted, are made and sunk in sections 262 ft. long, each forming a length of the complete double-tube tunnel. Each shell consists of two cylindrical tubes 23 ft. 4 ins. diameter and 26 ft. 4 ins. c. to c., enclosed in transverse rectangular diaphragms 55 ft. 8 ins. long and 31 ft. deep, spaced 12 ft. c. to c. These diaphragms rest upon the I-beams of the foundation grillage. The shells were built by the Great Lakes Engineering Works, of Detroit, at the shipbuilding yards at St. Clair, Mich., some 24 miles up the river from Detroit. Timbers and plank sheathing bolted to the diaphragms formed a hull or hulk which could be conveniently floated and handled. The hull was launched sideways, as in shipbuilding practice on the lakes. The total launching weight was about 600 tons. Four cylindrical steel tanks, 10 × 30 ft., were secured to the top by heavy bands, to furnish the desired buoyancy in sinking and adjusting the hull to its final position. These are removed later and used on other sections.

The first section was successfuly sunk on Oct. 1, 1907, as noted in our issue of Oct. 10. This was at the Detroit shore end. It was held in place only by cables, but these were led to the drums of a hoisting engine on shore, so that the shell could be adjusted as the work progressed. The concreting scow was held by its spuds close alongside the shell. Rubber hose attached to the two tubes (whose ends were closed by air-tight timber bulkheads) and to the four tanks were led to air pumps on the scow. From the shore end of each tube rises a 24-in. stack or manhole, 30 ft. high, and fitted with air pipes and valves. Over the center line of the northern tube was a steel column, having the faces painted in red and white checker marks to serve as a leveling pole in determining the elevation. At the bottom of each of the four bulkheads was an 18-in. valve operated by a stem with a hand-wheel on a platform bolted to the face of the bulkhead. A man was stationed at each platform, and at a whistle signal (2.55 p. m.) the valves were opened simultaneously. The sinking was very slow for some time, and gradually the shore end (on account of additional weight) sank more rapidly than the other, the water tending to collect at this end. This had been foreseen, and three temporary transverse bulkheads built across the upper part of each tube, so as to trap the air and form an air chamber above the water at the lower end. Owing to leaks in the manhole stacks, however, the air escaped and the shore end sank quite rapidly until buoyed by the air cylinders; the other end was partially submerged but still high out of the water. This plunge caused some rapid scrambling on the part of the men who were looking after the air pipes, cables, etc. Air was then pumped into two buoyancy tanks at this end of the shell, which then rose until the structure again floated on an even keel, with its upper surface just awash. On the next day the shell was sunk to its bearing on the foundation grillage. It was found, however, to be about 3½ ins. out of line and 2 ins. below grade. By means of the tanks and cables it was finally adjusted to correct position, the correct elevation being obtained by means of shims placed under the bearing surfaces by the divers.

The accompanying cuts, Figs. 1 to 4, show some of the stages of this interesting work. In Fig. 1, the hull or shell is in position ready for sinking (1.04 p. m.). The bulkheaded ends of the tubes are at the left, with the ladders and platforms for the men to operate the sinking valves. Air hose pass through the bulkheads. Above the north tube rises the steel sighting mast with an inclined brace. To the right of this are the two manhole stacks, and beyond are the four buoyancy tanks. Behind the shell are seen the three towers and the tall smokestack of the concreting scow. One of the derricks of this scow is placing ballast on the forward tanks. In Fig. 2 (3.23 p. m.) the shell is partly submerged, and the boat is ready to take the men from the valve operating platforms. In Fig. 3 (4 p. m) is shown the uneven settlement above mentioned; this continued until the water was within a few feet of the top of the manhole stacks. In Fig. 4 (4.35 p. m) the shell has been brought to an even keel, as may be seen by the tops of the four buoyancy tanks being [illegible] above the water. At the left is one steel sight mast, and the other rises beyond the tanks. [illegible] beyond the latter is seen the big dredging [illegible] already described. This view also shows [illegible] concreting scow, with its derricks, the [illegible] for the concrete mixing plants and the [illegible] carrying the pipes or tremies for depos[illegible] the concrete under water.

Two more sections are practically ready and one or both of these may be sunk this season. Work cannot be carried on during the winter on account of the heavy ice running in the channel. The style of joints between the sections is of new and special design. The joint will first be roughly bolted up by divers by means of projecting flanges, and will then be sealed by filling an annular space 3 × 18 ins. with grout injected under air pressure through flexible pipes from scows on the surface. The details of the different parts of the construction work are liable to modification in line with the experience gained in sinking and placing the first two or three sections.

DETROIT APPROACH.

The approach on the Detroit side is 3,675 ft. long, with a grade of 2%. This is steeper than the grade of the Canadian approach, as the westbound trains are the lighter. The first 1,540 ft. is in open cut with retaining walls, and the first 500 ft. of the tunnel portion was also built in open cut, except part of the north tube which was built by a shield on account of passing near the abutment of a city bridge. The center wall between the tubes was first built in a drift, and formed a guide for the roof shields of the arches. The concrete is placed in two layers, the outer and thicker portion being first placed. When this has set, it is faced on the inside with pitch and felt waterproofing, and the inner lining then put on. A twin-shaft, 75 ft. deep, was sunk at the shore end of the approach, with the intention of working back from this as well as from the open cut. An experimental drift was, however, run under the river bed towards the line of the river section, and not being sufficiently well bulkheaded at the end, the water broke in and flooded the shaft. Work is therefore progressing only eastward from the approach cut. A series of bore holes allows of sending down concrete and supplies at different points. This entire approach will probably be completed early in 1909.

WINDSOR APPROACH.

The approach on the Canadian side of the river is 6,500 ft. long, with a grade of 1½%. A shore shaft was built some time ago, but when it was desired to commence work here it was found that it was too small for a working shaft and showed signs of pressure. It was therefore decided to enlarge it, beginning at the top and putting in new and heavier timbering. In September, 1907, when this work had progressed about 35 ft., the lower end of the shaft caved in, and the slide filled in the shaft to within about 50 ft. from the top. The consequent movement of the ground undermined the abutments of a highway bridge, which is now supported by timber bents. Nobody was injured, but the shaft was abandoned, and a new one will be built farther back from the shore. This will be about 95 ft. deep. From the shaft, a bottom drift was run eastward to form the lower part of the concrete wall between the arches. Above this an upper drift was run westward (with a roof shield), the roof of the lower forming the floor of the upper drift. Heavy side and roof timbering was put in to stand the pressure of the clay. This drift was then filled with concrete, forming the central wall, the upper part of each side being shaped as the skewback for the roof arch, and having embedded in the face a steel channel which will form a guide for the roof shield. The material is excavated by shovels and draw knives and handled in cars by a cable haulage system. The car buckets are hoisted out at the shaft, and the clay discharged into dump cars to be used in filling the site for the new freight yards at this end of the tunnel. The concrete and other material is deposited through small shafts about 200 ft. apart, so that none of this material has to be taken down the main shaft.

At the end of the open-cut approach, the two roof shields for the twin arches are now being erected, and will be driven westward, each being guided on one side by the concrete central or partition wall already noted.

The entire land tunnel will consist of two single-track arches 25 ft. c. to c. Each will have a semicircular roof and two side benches with vertical walls, leaving just room between these walls for the maximum car clearance. In these thick side walls are embedded the vitrified conduits for the electric wires. The floor is of concrete, flat, with drainage troughs, and having recesses on each side to receive wooden blocks upon which the rails will be laid. An experimental section of this floor and track system, 100 ft. in length, has been laid near Detroit, on the Toledo Division of the Michigan Central R. R., and is giving good results. The blocks are held against outward movement by the ends of the recesses, while inward movement towards the central drainage channel is prevented by dowels embedded in the concrete and fitted to holes in the blocks.

DRAINAGE AND VENTILATION.

Drainage will be provided for by sumps of ample capacity at the lowest point under the river, at the shafts, and at the portals. The water will be removed by motor-driven pumps. No system of ventilation has been provided, as the tunnel will be operated by electric traction, and no locomotives carrying fires or working steam will be allowed to pass through.

THE STURTEVANT STEAM TURBINE.*

The extension of the steam turbine in marine and central-station work in units of enormous horse-power is now so well known as to excite little comment. Much less, however, has been heard concerning the development of the smaller turbine units, and the small reciprocating engine has been generally accepted as being usually more desirable than any small turbine. The turbine designers have not been idle by any means, and a few types are on the market for use in driving small generators, high speed pumps and blowers.

One of the latest manufacturing concerns to enter this latter field is the B. F. Sturtevant Company, of Hyde Park, Mass. The experimental work has been carried on for several years by Mr. Wm. E. Snow, of the engineering staff, and the turbine is now built under his patents. The resulting machine, which is a modification of the Riedler-Stumpf type, is claimed to fulfil the exacting requirements of this work. The steam enters at the sides of the bucket wheel through nozzles of Tobin bronze, shown in Fig. 3, and acts upon the buckets cut in the wheel. Similar buckets in the steel, stationary guide-plates form closed spaces in which the steam reacts, and as the steam is returned again and again to the moving buckets, each time at reduced velocity, more and more of its energy is absorbed. After expansion has taken place in four of these stationary buckets the steam escapes from the open-ended guide-plates into the interior of the turbine case.

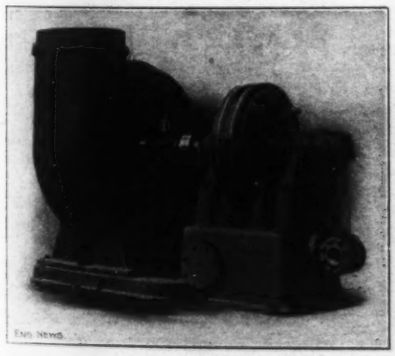


Fig. 1. Gas Blower Driven by 75-HP. Sturtevant Steam Turbine.

The Sturtevant turbine is made of the single-stage type in capacities ranging from 10 to 200 HP., and adjustment of the nozzles and buckets permit a wide range of power and speed for a turbine of given outside dimensions. Sizes above 200 HP. are usually made with from two to four bucket-wheels. The areas of the nozzles and buckets increase successively on these wheels to take care of the larger volume of the expanded steam.

The bucket wheel is made of a single forging, with the buckets worked out of the solid metal on a special automatic bucket-cutting machine, as shown in Fig. 2, which insures great accuracy and a perfect finish. This process insures a wheel of great strength, and as it runs between the two guide-plates there is no tendency to end thrust. A clearance of 1-16-in., all around the revolving wheel, greatly reduces the liability of contact from lack of alinement, due to heating or wear of the bearings. Should contact occur, however, it is claimed that it would be much less harmful with this wheel than it would be if the bucket wheel carried on its periphery a large number of inserted blades. The bucket wheel is also made in another type; these buckets are milled into the edge of the disk and the steam acts tangentially. Either side or tangential bucket may be used with either single or multi-stage type.

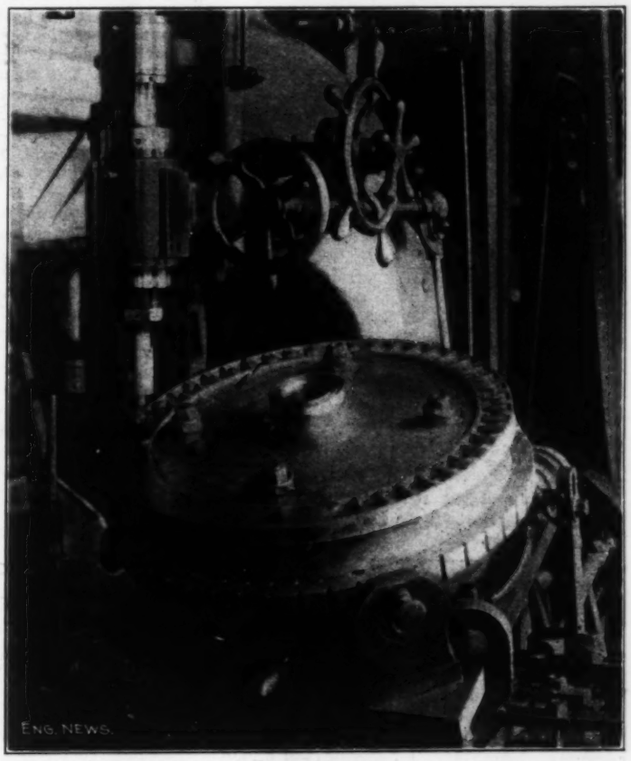


FIG. 2. METHOD OF CUTTING BUCKETS ON THE SIDES OF BUCKET WHEEL.

The speed of the Sturtevant turbine is controlled by the throttling governor, which is direct-connected to avoid the use of belts or gears. The governor is extremely simple, consisting of but four parts and one spring. Located upon the end of the out-board bearing, it is enclosed in a dust-proof case, and is direct-connected to the regulating valve, which is placed upon the inlet beneath the governor. The general appearance is shown in Figs. 1 and 4.

The Sturtevant turbine is very rugged, and it is claimed that it requires only a small amount of attention. The pressure upon the main bearings, which are the only surfaces in contact, is but 14 lbs. per sq. in., therefore the wear can be but slight. The bearings are of the self-alining ring-oiling type with solid linings of phosphor bronze. When in continuous operation the only attention required by these bearings is a weekly filling of the oil wells.

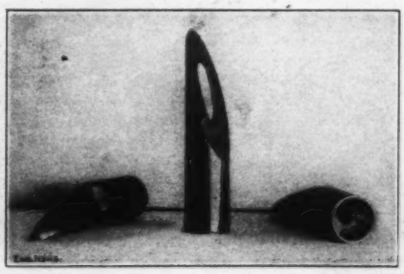


Fig. 3. Nozzles of Sturtevant Steam Turbine.

The casing is made in halves, so that the upper part can be removed easily for inspection of the bucket wheels. An annular passage supplies steam to the nozzles, and each nozzle can be shut off separately by means of a small valve. These valves may be seen in Fig. 1. The deep base is utilized for carrying the steam and the exhaust, which are connected directly to the base, thereby doing away with all unsightly overhead piping. The steam passages in the base are also arranged to form a separator, insuring the dry steam so essential to efficiency of the turbine and long life of the nozzles.

Among the advantages claimed for this turbine may be mentioned low speed. In many of the turbines now upon the market, the high speed is reduced by gears, or several bucket wheels are mounted on the same shaft, but the repeated use of the steam in the buckets of the same wheel give the Sturtevant turbine a moderate speed—ranging from 1,600 to 3,000 R. P. M. This speed permits direct-connection, and avoids the use of belts, gears, or other speed-reducing devices.

For installations in which the turbine is to be run non-condensing, no stuffing boxes are used on the shaft, steam tightness being secured by a short labyrinth or water packing. Since there is no contact between the rotary and the stationary rings of this packing, no adjustments are necessary, and the packing will last indefinitely.

No exact figures on the efficiency and operation of this type of turbine are at present available.

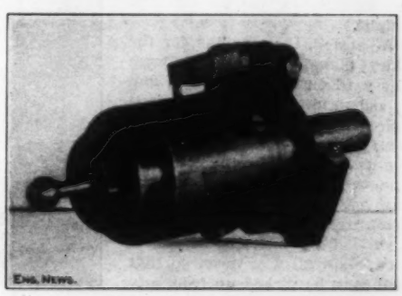


Fig. 4. Throttling Governor of Sturtevant Steam Turbine.

*From information supplied by the B. F. Sturtevant Co., Hyde Park, Mass.

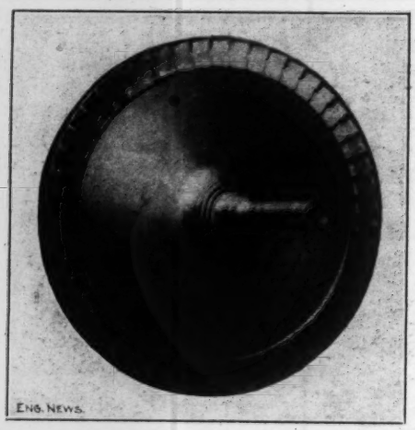


Fig. 5. Finished Bucket Wheel of Sturtevant Steam Turbine.

It is merely stated that in working practice their efficiency is about the same as that of reciprocating engines.

A NEW MACHINE FOR HANDLING COAL, ETC., INTO AND OUT OF STORAGE.

There will shortly be installed in the coal-storage yard of the United States Steel Corporation at Gary, Ind., a machine for handling coal and coke, into and out of storage, which seems successfully to meet the common objections—first cost, lack of flexibility, etc.—brought against systems and apparatus for storing and handling bituminous coal.

The machine is one designed to pick up loose material from any desired part of a storage yard 100 ft. wide and of any length. It will stack the material in piles up to a height of 40 ft., and will reload it from the stock pile into railway cars when it is to be moved. In performing either operation the machine has a capacity of 6 tons per minute and the operating cost is claimed to be less than 2 cts. per ton.

No overhead structure is required; nor any structure whatever, other than the 18-ft. track on which runs the moving platform, and the platform itself. The first cost of the system, and maintenance should therefore be low.

The machine, made by the Hamilton Mfg. Co., of Columbus, Ohio, is a development—an enlarged edition, so to speak—of the pit-car loader made by the same company for loading falls of coal in the mines after blasting, directly into mine cars. In its principle of operation the large machine for the Gary plant is identical with the smaller machine for underground use, a photograph of which is here shown. But while the smaller machine is built to operate in 4-ft. headroom, the larger is unlimited as to vertical height.

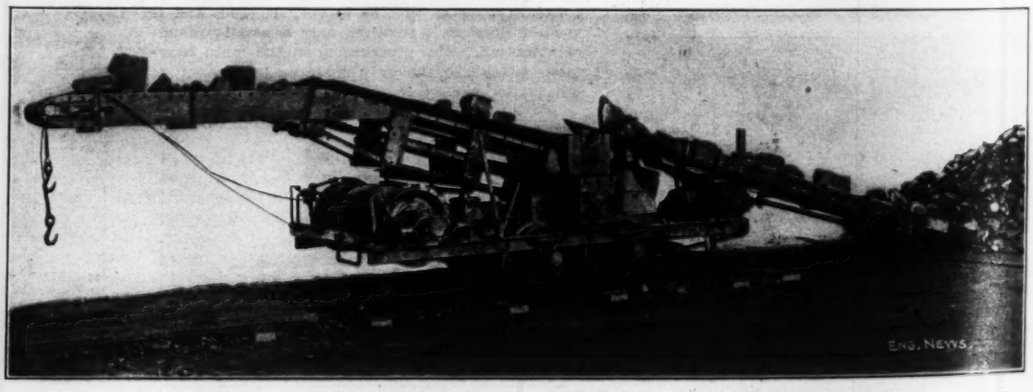
As stated, the machine for the Gary plant runs up and down the yard on an 18-ft. track, and is self-propelled. From a vertical shaft a radial sweep 50 ft. long extends, on which run the flights of the gathering conveyor and at the end of which is the gathering plate. Another radial arm carries the delivery conveyor. Both arms swing unrestricted in all directions, so that coal may be picked up from any point and delivered to any other point within reach of the arm.

The smaller machine for mine use is only 42 ins. high over all. It also is self-propelled. After the coal has been undercut and shot down, the machine enters the room; the pony truck carrying the front end is removed, and the posts for the feed chains are set up on each side of the room. The gathering plate or nose rests on the floor at the edge of the pile of coal. The car to be loaded is run beneath the end of the delivery-conveyor arm, and the gathering sweep starts moving to and fro across the room, advancing meantime. The flights of the gathering conveyor, which do not show in the photograph, carry the coal to the steel belt conveyor on the delivery arm, which conveys it to the car.

The stated rate of operation of the mine machine is 1,000 lbs. per min. The manufacturers state, however, that with a nose 4 ft. broad, moved across the floor at the rate of 2 ft. per min., a ton of coal per min. may be gathered and loaded.

When the mine cars are very large and heavy, the machine may be equipped with drums and cables for handling loaded cars and empties from the face to the cross entry, where the locomotive may pick them up. The machine illustrated is so equipped.

In addition to handling coal, the loader will handle any loose material such as rock, sand and gravel, tailings, etc. The Hamilton Mfg. Co. builds machines with capacities of from 1,000 to 12,000 lbs. per min. We are indebted to Mr. Wm. E. Hamilton, Vice-President and General Manager of the company, for the information from which the foregoing description was prepared.



CAR-LOADING MACHINE FOR UNDERGROUND USE IN COAL MINES.

THE RUSSELL SAGE LABORATORY: RENSSELAER POLYTECHNIC INSTITUTE.

It is only a few years ago that the famous old Rensselaer Polytechnic Institute was almost unique among engineering schools of high standing for its almost total lack of the apparatus that is now considered so important a part of an engineering education plant. Yet it turned out graduates so well equipped for their work that a very large proportion have won high place in the profession.

Part of its success was due, no doubt, to the fact that until very recently Rensselaer, notwithstanding its name, has been a school of civil engineering solely. The magnificent gift of Mrs. Russell Sage has made possible an expansion for which the preliminary steps were taken some time ago; and the Rensselaer of the future will be a polytechnic institute in fact as well as name.

The new Russell Sage laboratory, to be completed in 1908, will be devoted entirely to mechanical and electrical engineering work. The building will be of three stories, 244 × 80 ft.; the ground plan and the walls are to be of Harvard brick, with Indiana limestone trimmings.

The central portion, 50 ft. wide by 100 ft. deep, will be used together by the departments of Mechanical and Electrical Engineering, and will contain a large lecture room for 430 students, a reference library for the departments, a museum, a large drawing room, and a few smaller rooms. On each side of the central portion are two wings, each 100 × 80 ft., one devoted to Mechanical Engineering, the other to Electrical Engineering.

MECHANICAL ENGINEERING EQUIPMENT.—At one end will be a compound Corliss engine equipped with steam jackets, reheaters, condensers and special superheater. A duplex two-stage air compressor will be placed near the Corliss engine, and the air will be applied to experimental work with air hoists, tools, etc. Typical forms of steam turbines and a number of small reciprocating engines will be installed in this laboratory. A testing floor will be provided for the purpose of testing various motors, while a space for automobile testing will illustrate traction problems such as drawbar pull and friction. The refrigerating plant will contain a five-ton machine arranged for ice-making or refrigeration. The room for internal combustion engines will include not only gas engines, but also gas producers, oil engines and a Diesel motor. The pump room will be equipped with motor-driven triplex pumps, high-pressure pumps, water-works pumps, pulsometers, injectors, air lift pumps, hydraulic rams, hydraulic presses, reaction turbines and water wheels.

The basement floor will contain engines for valve-setting exercises, a room devoted to blowers and fans, a space for the test of water meters, a room devoted to dynamometers, small air tools, and air brakes and a shop for a mechanician.

There will be several rooms devoted to laboratory purposes on the first floor. The heat-insulation and radiation room will be devoted to the study of materials used in heating and refrigeration.

Adjacent to this room are the rooms for hoists, and for anemometer testing. In the hoist room the various forms of lifting apparatus will be tested. Jacks of various forms, triplex, duplex and Weston hoists, block and fall, air hoists and toggle joints will be found in the equipment. The anemometer room will include an apparatus for testing anemometers and another for testing tachometers, besides a number of forms of these instruments.

The room devoted to oils, gases and fuels will be equipped with a Mahler bomb calorimeter, a Junker calorimeter for gases and oil, a Parr calorimeter, viscosimeters, flash point and chill point apparatus, Orsat and Hempel gas analysis apparatus, together with means for making certain chemical tests. A machine for determining the friction of oils will also be located in this room.

Besides these rooms, the first floor of this west wing will contain the office of the department and two offices for the instructors, a topic room and two small laboratories for special work. The second and third floors of this wing are somewhat alike. The second contains the senior drafting room, a lecture room capable of seating 130 men, three topic rooms and three offices for instructors. The third floor contains the junior drafting room, a lecture room holding 100 men, three topic rooms and three offices for instructors.

ELECTRICAL ENGINEERING EQUIPMENT.—The east wing of the building will be devoted to the work of the department of Physics and Electrical Engineering.

The basement will contain a large room for a generating plant equipped with central switchboard, and two 25-KW. direct-current generators driven by a compound steam engine and a steam turbine. In addition to this source of power, up

to 100-[illegible], 220-volt, two-phase alternating current and 50-KW., 500-volt direct current can be obtained from the wires of the Troy Gas Co. This room will also contain transformers, motor generators, frequency changers and rotary converters. A room adjacent to the main switchboard will be equipped with a storage battery of 132 cells of 150 ampere hours capacity, arranged to give any voltage up to 250 volts.

A second large room will be devoted to the testing of the various types of alternating and direct-current generators and motors. The equipment will include all typical standard types of apparatus.

Three rooms will be assigned to the study of the applications of electricity to chemical processes. In the furnace room will be three electric furnaces and three electrolytic vats, each provided with a hood connecting with flues to the roof, to afford proper ventilation. A blower will be used when necessary to get rid of heavy fumes. This room will be connected with the main switchboard by large cables, and current of any volume or voltage, up to the capacity of the laboratory supply, will be conveniently available. Adjoining the furnace room will be an analytical room and a research room fitted with complete apparatus for volumetric and gravimetric analysis and for research in electrochemistry.

Two rooms will be devoted to photographic and blue print work.

The first floor will contain a lecture room seating 200, a smaller lecture room seating 100, two topic recitation rooms, coat room, office and private laboratory.

The second floor will contain a large laboratory for electrical measurements. A complete equipment of ballistic and aperiodic galvanometers, bridges, standard cells, condensers, resistance coils, inductance coils, ammeters, voltmeters, wattmeters, etc., will be provided so that all the determinations included in a course can be undertaken at the same time. A smaller laboratory will be devoted to the study of high tension and alternating currents.

Another room will be equipped with an ascillograph, and a wave form meter for the study of phase relations, field discharges, resonance and initial conditions in circuits and cables. Adjoining will be two rooms specially adapted for original electrical research. Included in the equipment will be an experimental cable having adjustable distributed and concentrated capacity and inductance adapted to the study of electrical oscillations in conductors. A large room will be set apart for the calibration, standardization and testing of instruments, apparatus and materials used in electrical engineering.

On the third floor will be a large room devoted to general physics, heat and sound.

Another large room will be devoted to work in light. Two rooms will be arranged for photometric measurements. The doors of these rooms and those of the adjoining rooms are placed opposite each other, so that a photometer bench 140 ft. long can be made immediately available for measuring powerful light sources.

A large drawing room with a smaller room adjoining will be devoted to the work in electrical design. In addition to the usual drawing tables there will be two large drawing tables arranged so that wall drawings can be made conveniently. The smaller room will be used for an office, and will contain files for records, drawings and blue prints. Another room on this floor will be specially arranged for research work in physics.

An apparatus room will be located on each floor, and will contain the apparatus especially used in work pursued on that floor. These rooms will be one above the other, and connected by an electrically operated elevator. In general every working table in the laboratory is provided with outlets for gas and direct and alternating current, and special circuits will be run from the main switchboard to all tables where the nature of the work demands such service.

The greater part of the electrical and physical equipment of the Sage Laboratory is at present installed in the Williams Proudfit Laboratory, and is available for instruction purposes at the present time.

NEW APPARATUS FOR THE STERILIZATION OF DRINKING WATER BY HEAT.

There is great need for some apparatus or method which will furnish pure drinking water at low cost, in localities where the existing water supply is impure and where the installation of purification plants on a large scale is not practicable.

Engineers and sanitarians have long had their attention concentrated on the supply of pure water to the dwellers in town and cities. But a great proportion of the population does not live in cities. With all the amazing growth of our great cities, fully half the people of the United States still live under rural conditions. The prevalence of typhoid and other water-borne diseases among these isolated dwellers in the country is very great; and in many sections it is almost impossible to obtain pure potable water for drinking. And while we look forward to the time when every large city shall have its filtration plant, that time is still far distant; and meanwhile there is a great need among city dwellers for absolutely pure drinking water.

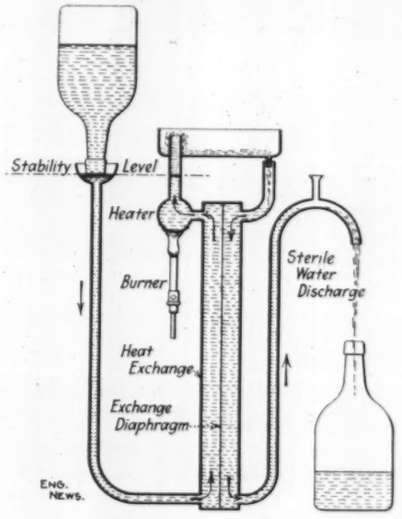


Fig. 1. Forbes Water-Sterilizing System. Simplified Diagram Showing Principle of Operation.

These are the conditions in the temperate zone; but when we turn to the tropics we find conditions even more serious. Recent investigations have shown the principal tropical diseases to be chiefly transmitted by impure water and by mosquitos. If the American or Englishman living in the tropics will drink sterilized water and protect himself from mosquitos, he can live in the tropics almost as safely as at home. Nor are the natives themselves immune from these diseases, as is commonly supposed. In the last report of the Philippine Commission we find the following:

> It has been claimed that Filipinos are practically immune to such diseases as are commonly contracted by drinking contaminated water. Doubtless the most susceptible individuals are killed in early infancy, and it is at best a case of the survival of the fittest; but examination of a very large number of stools shows that it is decidedly exceptional to find and adult Filipino who is not harboring one or more of the numerous parasites dangerous to human health which occur in these islands and which in the majority of cases gain access to the human system through drinking water. * * * The anemia which necessarily occurs, when a person harbors such an array of parasites, is certainly an important predisposing cause for the high infant mortality and for the low stature, poor physique, impaired vitality, low mentality, and lack of ambition so often seen among the poorer classes.

There is, then, a world-wide need for some means of treating water that will prevent it from spreading disease. The need exists, though but rarely recognized, in many rural districts and villages. The need is actually felt, though nothing like what it should be, by the contractor and engineer who has to perform work in the field; by the leader of military forces; by the sailor, the explorer, the prospector, the miner, the manufacturer whose plant is located outside the cities.

There are readily available numerous ways of securing a perfectly safe drinking water for any person or group of persons to whom a city-filtered water supply is not accessible. But under a wide range of conditions, which need not be reviewed here, it often happens that the most practicable, and at the same time, the surest means of making drinking water safe is by the application of heat. Sterility can be secured by distillation or by long-continued boiling, repeated at intervals of several days. But for the destruction of the disease germs common to water, absolute sterility is not required. After having been either distilled or boiled for any considerable period water has an objectionable, flat, insipid taste, because the gases normally contained in the water are driven off by the heat. Either boiled or distilled water must be cooled before it can be used. While boiled or distilled water may be aerated to improve its taste, it is difficult to do this on a small scale, and there is risk that

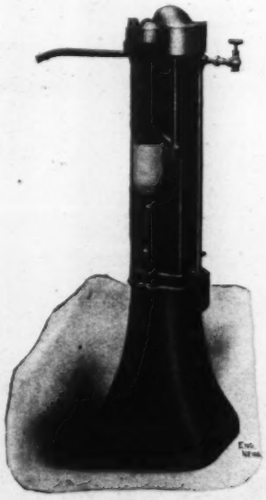


Fig. 2. Forbes Sterilizer, Type AI-G, Gas-Operated. For Residential or Similar Use. Capacity 12 Gallons per Hour.

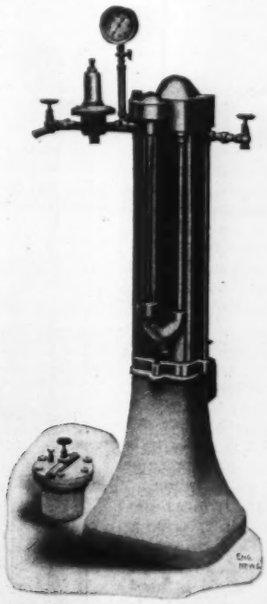


Fig. 4. Type AI-S Sterilizer, Steam-Operated. Capacity 18 Gallons per Hour. Similar Otherwise to Type A9-G.

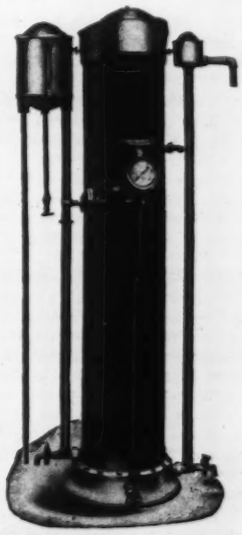


Fig. 5. Type S Sterilizer, Steam-Operated. Capacities 50 to 500 Gallons per Hour.

the process may contaminate the water with germs.

There is, however, one method of treating water which is free from these objections. That is the application of heat to water in a closed receptacle, so that the contained gas will not be driven off, and with apparatus so arranged that the stream of water leaving shall impart its heat to that entering, thus enabling the process to be carried on with only a small amount of heat. In such an apparatus the pure water delivered should retain its original gases and consequent agreeable taste, and it should be at a temperature not far above that at which it entered. While such water is not absolutely sterile it is common to speak of the plant producing it as sterilizing apparatus.

The problem of producing water sterilizing apparatus designed on these principles was taken up some eight years ago by the Forbes Co.* of Philadelphia, and after a long period of experimenting it is now placing on the market an extensive line of water sterilizers which deserve the attention of engineers and sanitarians.

The Forbes apparatus is so designed as to keep the water at the boiling point only for a second or two, hence the flat taste of ordinary boiled water is not noticeable in the product. A very simple "heat exchange" allows the outgoing water to give up its heat, by conduction, to the incoming water; additional cooling devices are unnecessary, and, as previously outlined, the cost of operation of the apparatus is greatly reduced.

The sketch reproduced in Fig. 1 illustrates the operation of the system. While the various sizes of equipment made by the company differ in numerous details, the essential principles of operation are the same. This sketch shows the simplest possible application of the principle: An inverted bottle is the source of supply; the water runs from the bottle into the cup below, and down the pipe into the bottom of one compartment of the "heat exchange," which it fills. When this compartment is filled, the water runs into the heater and part way up the vertical pipe above it; when it reaches the level of the mouth of the supply bottle it stops rising.

If, now, the gas burner be lighted, the water in the heater will boil, rise in the vertical pipe, and flow over into the pan at the top. This boiling lasts but a moment, after which the water at once flows away from the heated surface. It will be noted that no water can pass into the pan at the top which has not been brought to the boiling point.

The boiling over of the heated water lowers the level of the water in that portion of the system, and allows more to flow from the supply bottle. The sterilized water flows from the pan at the top into the other compartment of the heat exchange, where it gives up its heat through the thin metallic diaphragm to the incoming water. When the sterile-water side of the exchange is filled, the vertical outlet pipe leaving it at the bottom is also filled and the water flows into a receptacle provided for the purpose. The vent at the top of the discharge pipe is to prevent siphonic action.

By the exchange of heat, the water delivered at the discharge pipe is nearly as cold as that which is supplied to the apparatus (actually but 5° warmer in practice), while that which flows into the heater from the upper portion of the supply side is nearly at the boiling point when it reaches the heater. This, therefore, reduces the amount of heat necessary for operation to trifling proportions.

Instead of the inverted bottle and aerostatic feed, the well-known float valve method is used in practice for controlling the water level. It may be placed either at the point of supply or within the apparatus itself.

In practical apparatus the water may be raised to the boiling point by any one of the following agents: Live or exhaust steam in a coil, at a pressure as low as 1 lb., if necessary; artificial or natural gas, burned in a Bunsen flame; kerosene, alcohol, electricity, or a wood or coal fire.

When it is desired to subject the liquid treated to a lower degree of heat than the atmospheric boiling point, the apparatus is so constructed that the expansion of a column of liquid under heat will permit the passage of a portion over the "weir" at the top. On the other hand, when a temperature higher than the atmospheric boiling point is desired for treating any liquid, the apparatus may be enclosed and operated under a pressure corresponding to the heat desired. Thus any predetermined degree of heat may be used in treating liquids.

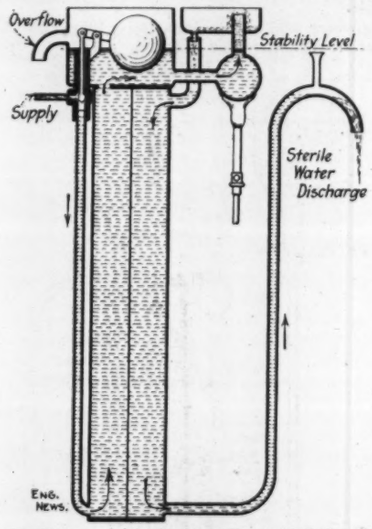


Fig. 3. Diagrammatic Section, Type AI-G Sterilizer.

While, as previously stated, the principle of operation as shown by Fig. 1 is that of all apparatus manufactured by the Forbes Co., two general, distinctive types have been developed: 1. The diaphragm apparatus. 2. The tubular apparatus. The various minor modifications of these two general types provide apparatus for any capacity and means of operating, under all possible conditions.

Under the head of Diaphragm Apparatus come the types shown in Figs. 2, 4 and 8. The larger type shown in Fig. 5, and the sterilizing portion of the portable plant shown in Fig. 7, are built under the tubular plan.

The division between the two main classes is based upon the method of carrying the sterilized water through the heat exchange.

DIAPHRAGM APPARATUS.—The smallest type of stationary apparatus is shown in Fig. 2, designated as the Type AI-G. This is a small, gas-operated sterilizer for residential or similar use, having a capacity of 12 gals. per hour with a gas consumption of 9 cu. ft. per hour.

A diagram section of this style sterilizer is shown in Fig. 3. This sectional sketch, it will be seen, is substantially like the diagram in Fig. 1, with the float-feed modification; for compactness of arrangement the float valve is located where it is operated by the hot water within the apparatus, just before it enters the heater and after it has traversed the ascending compartment of the heat exchange.

The diaphragm in the heat exchange is corrugated in deep folds, to afford large surfaces of contact on both sides. It is so attached at sides, top and bottom that there is no possibility of interleakage and consequent contamination of the sterilized water.

TUBULAR APPARATUS.—The tubular apparatus is of a much more substantial character than the diaphragm types, and is intended for severe service sustained for long periods.

The type S sterilizer, shown externally in Fig. 5 and sectionally in Fig. 6, is a good example of the tubular construction. This type is built for capacities of 50, 150, 250 and 500 gals. per hr., and is steam operated.

As to principle of operation this type follows Fig. 1. From the level-regulating chamber at the left the water is carried to the bottom of the heat exchange, where it enters above a tube sheet and fills the shell surrounding the tubes. Flowing over into the heater chamber, it rises inside the hood surrounding the heater tubes. When steam is supplied to the heater tubes the water boils over into the pan at the top, whence it flows down through the tubes of the heat exchange. The action thereafter is the same as in the diaphragm apparatus. Steam at a very low pressure will maintain this type in continuous operation. Exhaust steam at 1-lb. pressure, has been found sufficient in actual use.

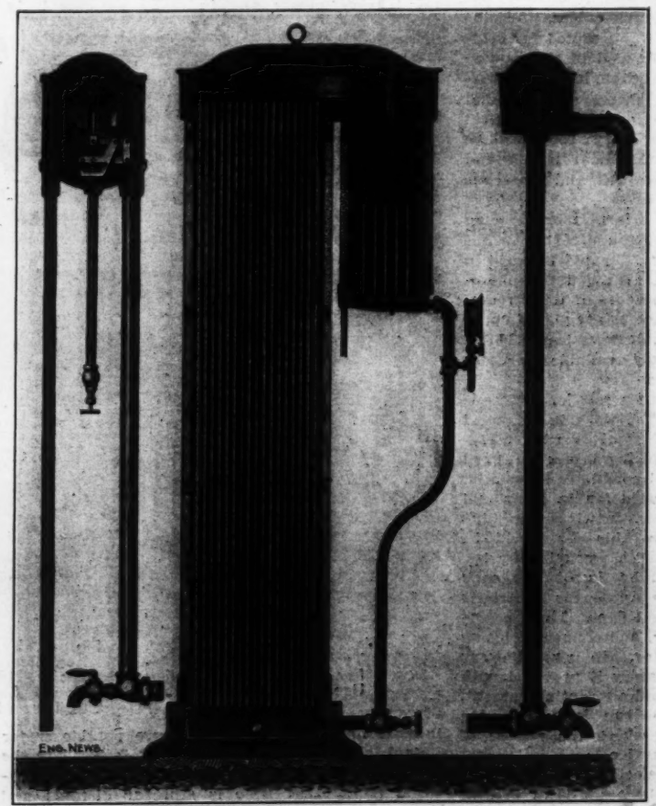


FIG. 6. SECTIONAL VIEW OF TYPE S STERILIZER, SHOWING ARRANGEMENT OF TUBULAR HEAT EXCHANGE.

Operating under atmospheric pressure, the covers of the various chambers are merely laid in place and not bolted or otherwise secured. This enables ready access for examination.

The cocks at the bottom are for washing out the apparatus; they discharge into pans provided for the purpose, and the pans are connected with the waste of the building. Direct connections from the apparatus to the sewer are avoided, for obvious reasons. The steam connection to the base of the heat exchange enables periodical sterilization of the apparatus itself.

The company manufactures, for large installations such as those for a town water supply, a sterilizing plant of the "unit" type which is closely akin in general construction and opera-

*1234-1236 Callowhill St.

tion to the Type S, save that the sterilizing units —any number of which may be operated in parallel, so to speak—are much larger than the Type S and have two sets of heater tubes each. The Forbes Company is prepared to instal plants of this type for the delivery of from 1,000 to 500,000 gals. of sterilized water per hour.

GENERAL DETAILS OF CONSTRUCTION AND OPERATION.—In both general types the design and construction of parts are carried out with care as to metallic contamination of the water.

The shells are of copper and brass, lined with block tin. In the diaphragm type the diaphragm is of sheet copper, tin-coated on both sides. In the tubular apparatus the tubes are of seamless brass, tin-lined.

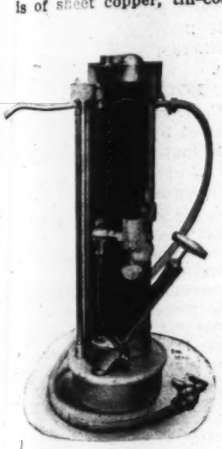


Fig. 8. Small Portable Sterilizing Outfit, Gasoline-Operated. Set Up for Operation.

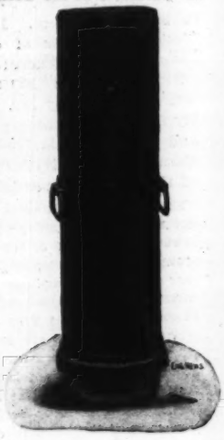


Fig. 9. Small Portable Sterilizing Outfit Packed for Transportation.

SCALE, DEPOSIT, CLEANING, ETC.—The question of scale or deposit inside the apparatus will be apt to occur to the reader. In all of the apparatus ample means are provided for inspecting and cleaning the surfaces, but in practical operation it has developed that scale and deposits do not accumulate as might be expected. The only point where any sign of scale has been found, after long tests, is in the heater of the gas- or kerosene-operated apparatus; in the steam-operated apparatus the nearest approach to scale which has developed in actual use is a soft, putty-like deposit on the heater tubes, easily washed off. Any precipitation of salts in the heat exchange partakes of the nature of a sludge, and is easily drawn off through the washout cocks.

EFFECT ON BACTERIA AND TASTE.—On these subjects a quotation may be made from the report of a board of U. S. Army officers appointed on Dec. 29, 1898, to investigate the sterilization of water for field troops. The whole series of tests extended over six months, during which more than thirty devices for treating water were tested. The board consisted of Dr. Walter Reed, Dr. E. O. Shakespeare and Prof. Victor C. Vaughn (Univ. of Mich.), each holding the title Major and Surgeon, the first in the regular army, the last two in the volunteers. Quotations from the report follow:

> As the result of numerous observations made with three styles of apparatus we find that water heavily charged with the typhoid bacillus, the colon bacillus or the bacillus prodigiosus, escapes from the apparatus entirely rid of living organisms.
>
> * * * * * * *
>
> Careful tests made by Dr. W. M. Mew, Chemist of the Surgeon-General's Office, show that there is no loss of the natural gases during the passage of the water through this apparatus.
>
> * * * All living, micro-organisms, except a few spore-bearing bacteria, are destroyed by the degree of heat attained during the passage of the water through the apparatus. The disadvantage of the escape of a few spore-forming bacteria is considered by the Board to be of no practical importance.

ECONOMY OF THE METHOD.—Naturally the question arises: How cheaply may sterilization be accomplished with this apparatus? Owing to lack of space, we can give but a general idea; but the following figures, furnished by the manufacturers and based upon practical tests, are of considerable interest.

In the larger apparatus, where the ratio of heat-transfer surface to the exterior surface is large, suitable insulation reduces radiation losses to a negligible quantity. With apparatus operated at a normal rate, the sterile water can be delivered at a temperature not more than 5° above the entering raw water. Therefore, neglecting radiation losses, there will be necessary, after the contents of the apparatus are heated, 5 B.T.U. per lb. of water treated. Allowing 10,000 available B.T.U. per pound of coal, 2,000 lbs. or 240 gals. of water may be treated per pound of coal burned.

This efficiency, with coal at $3.00 per ton as a basis, represents a cost for fuel alone of $6.24 per 1,000,000 gals. of sterilized water. In localities like Pittsburg or Scranton, where usable coal can be obtained at $1 per ton, this low cost is materially reduced. Under the ordinary method of boiling water and allowing it to cool naturally, all heat thrown off in cooling is of course lost, so that 1 lb. of coal will sterilize only about 58 lbs. or 7 gals. of water. In water-distilling apparatus, even with the multiple-effect systems of regeneration, the necessity of overcoming the latent heat of evaporation causes heavy losses. The distilling apparatus described in our issue of March 31, 1904 (p. 303), at that time the largest and most efficient ever made, produced but 45 lbs. of water per lb. of coal.

SPECIAL ARMY APPARATUS.—For a number of years the United States, England, Germany and France have been experimenting with the problem of furnishing safe drinking water to troops in the field, through the medium of portable purifying plants. Until recently the most advanced development was a plant on wheels, developed by the German government, with a capacity of 128 gals. per hour.*

Two years ago Capt. C. R. Darnal, Assistant Surgeon U. S. A., in charge of the Field Medical Supply Depot of the Army, suggested to Mr. Forbes that, with the experience acquired in developing the line of sterilizers which we have described, the Forbes Company should be able to improve upon the German portable army plant. After some experimenting, the Government on June 1, 1906, commissioned the company to build a "water wagon."

Fig. 10. Portable Sterilizing Outfit with Barrel Accessories. When Packed the Entire Outfit Goes in the Large Barrel.

The wagon was completed and turned over to the Government late in August, 1907. Its appearance is clearly shown in the photograph, Fig. 7. The tests which were immediately made upon it were somewhat surprising in their results: the requirement set was that of the German apparatus—128 gals. per hr.; the Forbes wagon delivered 400 gals. per hr. of sterilized and filtered water.

Briefly, this "water wagon" embodies a small, specially designed water-tube boiler; a 2 × 3 × 2-in. Worthington duplex steam pump; a double copper-cell bone-black filter; a copper tank for raw filtered water, and one for sterile water—the latter of 150-gal. capacity—both tin-lined; a special, tubular type Forbes sterilizer, steam operated; an auxiliary hand pump; and two sterile-water supply pipes, each equipped with seven faucets for filling canteens, etc.

The apparatus is mounted on a steel-frame truck, equipped with standard U. S. Army escort-wagon wheels and axles. Exhaust steam from the pump is used to operate the heater of the sterilizer.

At different rates of operation, the tests showed the following differences in temperature between the incoming water and the sterile output:

At 150 gals. per hr.	6°-7° F.
At 300 gals. per hr.	12° F.
At 400 gals. per hr.	16° F.

The apparatus steams in six minutes from cold water, and starts operating in 11 minutes. To test it for durability, all tanks, pipes, the filter, etc., were filled, and the wagon taken for a 20-mile trot over rough roads; it did not show any leakage at the end of the trip. The total weight of the outfit is about 3,150 lbs.

SMALLER PORTABLE APPARATUS.—The adaptation of the smaller sterilizers to portable form, and the development of suitable auxiliary apparatus, has been carried out by the Forbes Co. To engineers who have superintended opera-

FIG. 7. PORTABLE ARMY OUTFIT FOR WATER STERILIZING. CAPACITY UNDER TEST, 400 GALLONS PER HOUR. NOW IN COMMISSION WITH U. S. ARMY.

*A description of this outfit appeared in the "Scientific American" for June 2, 1906.

tions in isolated localities—tropical railway construction, for example—where the water supply, if not absolutely dangerous, is questionable, a small portable outfit which will provide strictly safe drinking water cannot but be of interest.

In Fig. 8 is shown a modification of the Type AI-G, set up for operation. The same outfit packed is shown in Fig. 9—neither a big load for a burro nor a bulky part of a wagon load. A portable sheet-iron furnace is available for this type, the whole furnace packed being about the size of a large water pail.

We have reproduced the photograph shown in Fig. 10, to illustrate a combination suitable for isolated construction camps. When this outfit is packed, the large barrel contains all the rest; the base of the iron standard forms the cover, and may be locked on by the hasps.

For the information upon which this article is based, and for their courtesy in loaning the photographs and drawings used for our illustrations, we are indebted to Messrs. John Forbes and Chas. W. Kesser, of the Forbes Co.

ANNUAL CONVENTION OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.

The 17th annual meeting of this association was held at Milwaukee, Wis., Oct. 15, 16 and 17, the headquarters and place of meeting being at the Republican Hotel. The proceedings dragged rather tediously at first, and so much time was lost that it was necessary to hold two extra sessions and to postpone most of the excursions until the fourth day.

The first session was called to order at 10.30 a. m., on Oct. 15, by the President, Mr. J. H. Markley (T., P. & W. Ry.), and was devoted to addresses by the Mayor of Milwaukee, Hon. S. M. Becker, and by Mr. R. H. Aishton, General Manager of the Chicago & Northwestern Ry. These addresses were responded to by Mr. H. Rettinghouse (C. & N. W. Ry.). The remainder of the session was devoted to routine matters. The reports of the Secretary and Treasurer showed a membership of 335 (exclusive of about 40 new members), and a bank balance of $350.

At the afternoon session a short talk on the Quebec Bridge failure was given by Mr. W. H. Finley (C. & N. W. Ry.). This session and the two sessions of the following day were devoted to general discussions on the reports presented at the 1906 meeting, and to the reports of the standing committees.

STOCK DRENCHING APPARATUS.—As to the apparatus used for sprinkling live-stock in cars to prevent overheating, it was pointed out that a solid heavy stream sometimes causes injury to small stock, and the better plan is to use a nozzle which will spread the stream and form a spray. The Michigan Central Ry. was reported as having good results from blocks of ice put in the stock cars. The difficulties of complying with the law that requires that stock shall not be left more than 28 hours in the cars were also noted.

COFFERDAMS.—In regard to the use of steel sheet piling in this class of work, Mr. J. H. Markley (T. P. & W. Ry.) stated that he had not generally found it practicable to pull this and use it over again, a feature usually claimed as a special advantage. On the whole, he preferred wooden sheet piling.

BUMPING POSTS.—Several speakers alluded to the carelessness of enginemen in running cars against the posts. In one case, at a deep-water terminal, the wrecking crane had frequently to recover cars which were sent through or over the bumpers and into the water. The posts are now replaced by low bumpers to catch the wheels, and several speakers referred to the advantages of bumpers of this kind which will catch the wheels and trucks instead of the body of the car. Even massive concrete blocks will be displaced by the violent bumping of cars. One of the most effective stops is a heap of dirt or cinders, which will absorb the momentum without causing serious injury. This should be sloped so as to first engage the wheels.

WATER SUPPLY.—The standing committee presented a very brief report with particulars of the results of tests at various pumping stations using gasoline and steam pumps. Mr. Montzheimer (C., L. S. & E. Ry.) stated that gasoline engines can be converted to use kerosene at small expense, and one member stated that he has in use a combination plant. Gasoline is used in starting and for 15 or 20 minutes, or until the cylinder is heated; it is then shut off and kerosene used to run the engine.

TIMBER BRIDGES AND TRESTLES.—There was some discussion as to the arrangements of stringers and floors. One member spoke of using angle-irons on the corners of the guard timbers, this being in accordance with the requirements of a railway commission.

FIRE PROTECTION.—This related to the protection of wooden structures. Three classes of protection are: A, to cover the caps and stringers with galvanized iron, bent down at the sides to shed water; B, to use a ballasted floor; C, to use a solid floor or deck to which the rails are spiked and upon which is laid a thin covering of gravel to protect it from cinders. Mr. J. H. Markley (T. P. & W. Ry.) uses the first method, but does not apply the covering for a year after the structure is built, so as to allow the timbers to season thoroughly. The merits of water barrels were discussed and some members thought the expense and labor involved in maintaining them could be spent to better advantage in some system of floor protection. On the Maine Central Ry. a strong solution of brine boiled down is used to prevent trouble from freezing and in some cases the presence of this supply has saved important structures from destruction.

PRESERVATIVES FOR WOOD AND METAL.—This report pointed out that the necessity for good protective paint on metal work depends largely upon atmospheric conditions. The division of the chairman of the committee extends from the Pacific coast, where sea fogs and salt moisture have to be considered, back to the dry desert country where it is an easy matter to protect steel structures:

Crude oil has been used during the last 10 years on wooden bridges with good results. It has been our practice to apply it liberally to bents and deck. It prevents to a large extent the formation of rotten pockets and checking of timber, as it penetrates the wood instead of forming a surface coat. This year we renewed some box culverts built of 3-in. California redwood and placed in the fills when the road was built in 1881, giving a life of 26 years. These culverts, though considerably decayed, had not collapsed and were still doing service.

As to metal preservers, several kinds of paint have been used, with varying success, but the best results have been attained with the use of red lead mixed with linseed oil. The steel should be thoroughly cleaned and one or two coats of this paint applied. Care must be taken to rub the first coat firmly and uniformly on to the metal when it is dry, leaving no pores unfilled, as the perspiration of the metal will work out on such places and rust will appear. After having established a good base of red lead paint, two coats of any good paint should be applied. The following is from a letter from Mr. J. Wallace, Assistant Chief Engineer of the Southern Pacific Ry.:

In reply to your inquiry relative to paint for protecting steel bridges along the coast lines. I presume you have reference particularly to structures lying close to the ocean shore. These bridges are much more difficult to protect, owing to the fogs and moist salt air. We have tested a number of different kinds of paints, many of which have been complete failures. In general, we find the best protection is a coat of red lead covered with graphite paint. For bridges in the interior of the state, we use graphite paint only.

In the discussion, creosote (applied under pressure to piles and timbers) and carbolineum (applied as a paint) were mentioned. Mr. W. O. Eggleston (Erie Ry.) had seen sticks 12 × 16 ins. completely impregnated by creosote forced in under heavy pressure, but others had not found such timbers completely penetrated. Mr. Reid (L. S. & M. S. Ry.) thought that failure to impregnate the wood to the center of the stick might result in rotting from the interior. Mr. Eggleston also spoke of oil soaked hemlock lasting 20 to 30 years in the Pennsylvania oil regions. The use of ties and bridge timbers treated with crude oil on the Atchison, Topeka & Santa Fe Ry. was noted, and it was remarked that there seemed to be no additional fire risk. The only other preservative mentioned was chloride of zinc, and Mr. A. S. Markley referred to the successful use of this material with ties of very inferior oak on the Chicago & Eastern Illinois Ry. As to preservatives of metal, he recommended the use of "the best paint," but discreetly refrained from [illegible] to a question regarding the name and make of "the best paint." It was pointed out that frequent painting is desirable, rather than to let the paint get old and ineffective and the metal to begin to corrode before repainting is considered. The experimental use of a sticky paint covered with paraffin paper, as a protection against the action of gases in a trainshed, was mentioned.

PROPERTIES OF TIMBER.—Prof. W. K. Hatt (Purdue University) gave a talk on the properties and strength of timbers, especially in regard to bridge stringers. He illustrated this by exhibits of samples of different kinds of timber, showing their structure.

SMOKEJACKS FOR ROUNDHOUSES.—This was presented by Mr. C. A. Lichty (C. & N. W. Ry.), and was accompanied by numerous letters and drawings relative to individual practice and showing great diversity of opinion. An abstract of the report proper is given below:

The committee is unable to say which is the best form and material for engine-house jacks. It is safe to say, however, that some of the compositions of asbestos have proved to be failures, and railway men are as eager as ever to find a substitute for the many kinds of cumbersome and expensive jacks now in use, which will be reasonably cheap at first cost and easy to maintain in service. The jacks are made in all conceivable shapes, sizes and forms, to meet certain requirements and conditions in the different kinds of engine-houses, but generally they are classed as two distinctive types: one having a telescopic drop section fitting down closely over the stack of the locomotive after it has been placed; and the other having a large flaring section which is stationary, under which the engine may be placed without accuracy, and which is larger in every way than the first named type. The latter style answers to a greater extent for ventilation on account of its larger dimensions and must necessarily allow the escape of more heat in cold weather unless special arrangements are made to avoid it.

The various forms of iron and steel when used for this purpose decompose very rapidly, cast iron being better than wrought iron or steel. But cast-iron jacks when made thick enough to last any considerable length of time are cumbersome and expensive and often crack during the first season owing to contraction and expansion. The sheet iron jacks last ordinarily only two to five years. Tile (or sewer pipe) has been extensively used, but in northern climates it is being abandoned on account of being cumbersome and cracking when subjected to extreme heat and cold. This form of jack usually consists of several joints of tile mounted upon a roof casting and surmounted by a sheet metal cap, and having either a telescopic section or a stationary hood under the roof, made in either case of iron. This lower section, and the cap, are subjected to rapid disintegration and have to be renewed frequently.

Wood seems to withstand the action of the gases better than metal and it has been successfully used by some roads for many years without any trouble whatever. Other roads experienced loss from fire and many are prone not to use them, fearing similar results. The committee recommends a careful investigation of wooden jacks to ascertain if possible whether the fault has not been in the style or methods of construction and misuse where failures have occurred, rather than in the kind of material. It is quite certain that a wooden jack fitting closely over the mouth of the stack, or nearly so, would be more likely to cause trouble than a large mouthed jack, where plenty of air passes through with the smoke and gases.

Various compositions of asbestos, cement, etc., have been extensively experimented with in recent years. Many of these have proved to be short lived, and none have stood the test sufficiently long to prove that they are worth the price which is charged for them, regardless of the fact that they may be guaranteed by the manufacturers for a specified term of years.

The appendix to the report gave cast iron jacks a life of from one year to 20 years, and wood up to 12 years. The general trend of the report and the discussion was strongly in favor of wood as being durable (15 to 20 years) and cheap, with little real liability of fire. They may be painted and sanded as a protection against fire, but damp and soot soon form a protective coating. The interior should be free from projections, and copper or composition nails should be used. In some cases they are lined with asbestos board or even built of sheets of this material secured to corner angle irons. Mr. Reed (L. S. & M. S. Ry.) thought a cement lining would flake off under the

action of heat. Mr. Eggleston (Erie Ry.) described the form of wooden jack used on his road, and remarked that circular jacks are generally of too small diameter to carry off the volume of smoke and gases produced when an engine is being fired up and has the blower turned on.

LOCKS FOR FREIGHT HOUSE DOORS.—This brief report was also presented by Mr. Lichty, and showed several locking devices used on different roads. There was no discussion.

LIGHTS ON DRAWBRIDGES.—This report showed the arrangement of lights on certain bridges, and also the construction of the towers or frames in which the lights are carried. Mr. Reid (L. S. & M. S. Ry.) pointed out that the arrangement and color of lamps do not rest with the railways but are specified by the U. S. Lighthouse Board and that its published regulations show the arrangement for high and low bridges of swing, bascule and other types over navigable channels.

PROTECTING STEEL BRIDGES FROM BRINE DROPPING FROM REFRIGERATOR CARS.—This report shows that little is being done beyond keeping the steel work painted. The Illinois Central Ry., however, is using galvanized iron troughs placed between the ties and draining to the side of the bridge. The troughs have top flanges which rest on the ties. Mr. J. P. Snow (B. & Me. Ry.), in a written discussion stated that the matter had been taken up some years ago by the Master Car Builders' Association, with the intention of compelling the owners of such cars to provide tanks of such capacity as to require emptying only once in 12 hours. The opposition was so great that the plan was abandoned, and Mr. Snow thought that no power less than national legislation could compel such action in the face of the powerful opposition of the car owners. In the meantime, structures must be protected by the bridge departments, and this can best be done by keeping the surfaces well coated with a good and durable paint. The use of concrete decks is also a protection. Mr. Eggleston (Erie Ry.) thought the matter should again be reported to the Master Car Builders' Association, on account of the damage to bridges, switches, etc. It would be better to stop the discharge of brine than to keep trying to protect the steel work.

CONCRETE WORK.—Three reports dealing with the use of concrete were presented, but were received with practically no discussion. The first of these dealt with concrete buildings and gave four systems of construction: 1, monolithic construction; 2, lighter monolithic work reinforced with steel; 3, concrete blocks; 4, metal lath plastered with Portland cement mortar. Concrete blocks were not regarded with favor, but the statements as to their unsatisfactory appearance were entirely too sweeping; many blocks are now made of excellent appearance (both as to edges and surface) as well as of ample strength. The results depend largely upon the methods and care in manufacture. This report quoted the building ordinances of St. Louis as relating to concrete building work. The second report dealt with the expansion and contraction of concrete, and recommended expansion joints 40 to 50 ft. apart in retaining walls 10 to 20 ft. high. The third report related to the action of sea water on concrete, and consisted simply of a few replies to the committee's inquiries. All of the replies seem to agree that concrete should be faced with granite above low water, as the area between high and low water has a tendency to disintegrate; also that this disintegration is increased by frost and ice. Some extracts from this are given below:

CONCRETE IN SEA WATER.

1 (New York).—Where there is no ice formation, concrete made in air with fresh water and then sunk into sea water, works well, but shows a tendency to disintegrate slightly on the faces between low and high water levels. I would not deposit concrete direct into sea water. Where the salt water permeates the whole mass of concrete the faces disintegrate faster than where the concrete mixed with fresh water is made in air and then sunk into position in the sea water. Between low and high water the faces of the concrete show a tendency to disintegrate.

Where there is severe cold and a large ice formation concrete exposed to the rise and fall of the tide will disintegrate on the exposed faces to a depth of ⅛-in. to ¾-in. If this disintegrated portion is faced with cement mortar each spring there will be no further trouble until the ice goes out the next winter. Bridge piers and abutments should be built from about 2 or 3 ft. below extreme low water to the top of the masonry, of granite ashlar dressed smooth on the faces exposed to the ice and salt water and backed with concrete.

2 (New York).—Mix the concrete dry and put it through chutes into the water. Never mix with water before putting into bed. In the vicinity of New York most of the concrete is made into blocks and sunk to the depth required and handled by divers. This seems to be the better method and gives more satisfaction than trying to put it in in any loose form. The rise and fall of the tide seems to have no effect whatever on the concrete blocks. The frost does not seem to have any appreciable effect on the concrete.

3 (Boston).—Concrete deposited direct into sea water gives satisfactory results if the material and method of work are right. The cement should contain not over 2% sulphuric tri-oxide and a low content of magnesia. The sand should be good, and crushed stone should be used rather than pebbles. The mixture should be not leaner than 1:2:4, and it should be deposited either with a tube or a bucket on the O'Rourke pattern, which opens wholly inside the bucket, making practically a closed tube for the concrete to drop through. In using a tube the first charge is bound to be washed, hence it is best to begin operations each morning out in the area well away from the forms, so as not to have washed concrete on the outside of the mass when finished. This is difficult to impress on the workmen, as they always want to start operations at one corner. At times there is trouble from the milk of lime, which is too heavy to float away in the water. If it collects more than about 3 ins. thick, it should be pumped off or otherwise disposed of; it will not harden, and if covered into the mass will make a weak section.

If concrete is properly deposited in pure sea water it sets even stronger than in air, but I prefer to have a stone masonry facing between high and low water. If concrete is exposed to the sun's action between tides it must be extraordinary good to withstand the combined action of all the forces acting to disintegrate it. There are a large number of concrete piers around Boston and there has been no failure or trouble due to lack of integrity of the concrete. It will be noted that above low water the pier is faced with stone. The chairman has made it a particular object to examine a number of structures of concrete in tidewater in the vicinity of Boston, and has found in every structure disintegration was taking place with more or less rapidity between high and low water. In some cases, notably the arches under the piers at Charlestown navy yard, this disintegration was to such an extent as to seriously affect the stability of the work. He has been informed by those who are constantly on the work at these different places that this disintegration was considerably more rapid in cold weather when frost was experienced than at other times, although disintegration occurs even in warm weather. In some cases the concrete scales off in quite large patches, but in most of these cases it comes out in small particles, so that the stones which form a part of the concrete were left projecting from 1 in. to 2 ins. beyond the general surface, or until such time as the weight of the stone would offset what little holding power remained to the concrete at the inner point of the stone. The same trouble is found with granite above low water. In several places the mortar has disappeared in the joints and had to be repointed after three or four years.

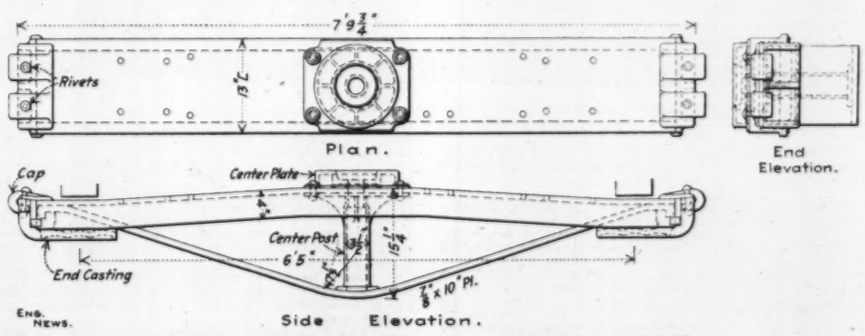
A concrete pier on the Providence River, at Warren, R. I., which was built some 25 years ago with a mixture of sand and cement of about 1 to 3 is in a good state of preservation, except between high and low water, where it is worn away in places from 4 to 8 ins. This looks as if it was done more by the current and ice as the tide ebbs and flows, rather than by the combined action of frost and tide water rising and falling. The current runs at about 8 miles per hour, and causes quite a whirlpool at its passes the pier.

The entertainments included a theatre party and an informal reception at the Republican Hotel, at which a lecture on Milwaukee (illustrated by stereopticon views) was given by Mr. R. B. Watrous, Secretary of the Citizens' Business League. This proved unusually interesting. There was a trip by boat to the new concrete breakwater, and a trip by special train to the shops of the Chicago, Milwaukee & St. Paul Ry., the Allis-Chalmers Co., the Wisconsin Bridge & Iron Works, and the Bucyrus Co. At the railway shops, one of the principal points of interest was the 500-ton coaling plant with four elevated pockets. There are also 10-ton auxiliary pockets, each mounted on a weighing scale and discharging into the chutes, so as to accurately weigh the quantity delivered to each engine. The coal tracks, conveyers and hoppers are in duplicate, to permit rapid unloading of the cars and to provide against failure of the machinery. Another interesting feature was a group of six mechanical ash hoists serving a 26-stall roundhouse; this house is heated by hot-air and instead of smokejacks it has a continuous circular monitor or ventilator in the roof. At the Bucyrus Co.'s shops a demonstration was given of the work of powerful wrecking cranes.

The election of officers resulted as follows: President, R. H. Reid (L. S. & M. S. Ry), Cleveland, O.; Vice-Presidents, J. P. Canty (B. & Me. Ry.); H. Rettinghouse (C. & N. W. Ry.); F. E. Schall (L. V. Ry.); W. O. Eggleston (Erie Ry.); Treasurer, C. P. Austin (B. & Me. Ry.); Secretary, S. F. Patterson (B. & Me. Ry.), Concord, N. H. The next meeting will be held at Washington, D. C. (but the Executive Committee was empowered to change this to Toronto, Canada, in case it should be found impracticable to make the necessary arrangements.)

A STRUCTURAL STEEL TRUCK BOLSTER WITHOUT LOAD STRESSES ON THE RIVETS.

A new design of truck bolster for freight cars has been introduced which is built up of structural steel and castings, but which has as its special feature the elimination of all rivets subject to stress under load. It will be seen by the accompanying cut that it is a simple truss, having a steel channel as its main member, trussed by a flat bar which passes under a center post. Ordinarily, these two members would be riveted together at the ends, but in this case the ends of the plate are upset to form hooks engaging with lugs on end castings. A clip or cap at the end fits over the channel and the casting, and it is secured by two rivets, which serve merely to hold the parts in place and do not take any strain due to the load. The cut shows the bolster, as designed for 50-ton cars of the Erie Ry., and it will be seen that in this case it is to be used in connection with roller bearings on the axle boxes. For plans and information we are indebted to the manufacturers, the Pittsburg Steel Foundry Co., of Pittsburg, Pa.



TRUCK BOLSTER WITHOUT LOAD STRAINS ON RIVETS.

REPORT OF THE TRANSVAAL COMMISSION ON THE USE OF WINDING ROPES, SAFETY CATCHES AND APPLIANCES IN MINE SHAFTS.*

Historical.

18. The subject which this Commission has been appointed to investigate is not a new one. It has, in fact, for many years continued to attract public attention in all countries where mining is carried on, especially in the United Kingdom and Germany. There has been, however, some diversity of opinion among the various authorities as to the best means of promoting the safety of persons and property in mine shafts, British opinion being, as a rule, more conservative than Continental, and more or less averse to the employment of safety appliances as complicating the conditions of raising and lowering without positively securing any compensating advantages.

19. The appointment of the Commission was due mainly to two circumstances, namely:

(1) The distressing accident which occurred at the Robinson Deep Gold-Mining Co., Ltd., on April 25, 1904, following on a similar accident at the Geldenhuis Deep in 1901, when, in the former case, a flat winding rope composed of steel wire broke and precipitated to the bottom of the shaft a cage full of natives, numbering 44, all of whom were killed; and

(2) A number of inventors in this and other countries having, in consequence of the above-mentioned and previous failures of winding ropes or their attachments in various mining centers, turned their attention towards the improvement of existing devices for preventing the uncontrolled descent of skips or cages in the event of the winding rope breaking, as well as those for restricting the damage to life and property caused by the inadvertent hoisting of such conveyances beyond the normal terminus in the headgear.

20. Several persons in this Colony have directed a large amount of energy to the subject, more especially to the former section of it; and, struggling with praiseworthy persistency against the various difficulties incidental to practical trials and experiments, have submitted designs and models to the Mines Department. Some of these were highly ingenious and, in a few instances, novel; but in most cases the ideas advanced were simply modifications of the better-known types of unreliable safety catches already in use. It was felt, however, that the degree of interest which had been aroused in this important subject, and the amount of endeavor which had been devoted to ensure success, should not be allowed to dwindle away without securing for the service of the mining community whatever tangible benefits might be possible.

21. Although Commissions of Inquiry had, in past years, investigated this and kindred matters in Europe, it was generally considered that—owing to the rapid evolution of engineering science as applied to mining practice, due principally to large and growing increases in the scale of operations and in the depths at which they are conducted and projected, necessitating the hauling of men and minerals at a higher speed and in greater quantities—a thoroughly representative committee of mining men in this Colony should take up the work where it had been left off by others, and, after investigation, test under practical conditions such devices as might appear to give promise. Such a committee would, it was hoped, render good service in eliminating ideas which were unsound in theory and which tended to hamper the efforts which have been so doggedly directed towards the solution of this important problem, and tend to concentrate the energies of those who have the subject so much at heart, along those lines which would appear the most likely to lead to ultimate success.

22. In all other countries where up-to-date mining is practised, such as Great Britain, the United States, Germany, Belgium, France, Australia, etc., public interest had been aroused whenever the failure of a winding rope had caused the loss of a number of lives. The first safety catch of which there is any record as having been used successfully, is that of Fourdrinier in the year 1851; this was of the wedge-spring type.

23. With the introduction of safety catches and the influence of the Coal Mines Regulation Act, which came into action in the early '50's, the beneficent results shown in the following tables were achieved.

The proportions of fatalities to men employed in British mines, due to hauling accidents and falling down shafts, etc., were:

Years	1850—1860,	1 killed for	1,161	employed.
"	1861—1870,	1 "	2,121	"
"	1871—1880,	1 "	3,557	"
"	1881—1883,	1 "	4,718	"

24. This consistent diminution in the proportion of men killed is due to improved methods and appliances, among which detaching hooks and safety catches form a not inconsiderable part, combined with increased care on the part of all concerned.

25. In England a Royal Commission, under the presidency of Sir Frederick Abel, was appointed in the '80's; the report of this Commission, however, was not in favor of the employment of safety catches.

26. In the course of the inquiry of the Abel Commission it was pointed out, as a reply to those who objected to safety catches on the ground that "a good rope is the best safety catch," that some disasters had occurred irrespective of the quality or condition of the rope.

Since that time there have been several instances of this nature, notably that at Tirpentwys Colliery, Monmouthshire, in 1902, whereby eight lives were lost through the breaking of a rope owing to its being knocked off the pit-head sheave. This fact caused the Government Inspectors of Mines to consider seriously the advisability of enforcing the use of safety catches; but after a full inquiry into Continental practice, the Inspectors were still unconvinced of the desirability of taking such a step.

27. Another serious rope accident, which may be described as the fracture of a rope through an overwind, and which resulted in the death of 17 miners, took place at the General Blumenthal Mine in Germany in 1898, and caused the appointment of the Dortmund Mining District Commission in the following year. The recommendations of this Commission were:

(1) That speed safety appliances—that is, those contrivances which prevent excessive speed, overwinding, and overlowering by automatically closing the throttle-valve and applying the brake—afford greater security than those contrivances with indirect action, such as warning bells, etc.; but the degree of perfection attained is not sufficient to justify their compulsory adoption, and it was recommended that every assistance should be afforded to those endeavoring to improve them.

(2) Recording speed indicators should be attached to winding engines.

(3) Converging guides, where there is sufficient head room, are of use in case of overwinding even if they fail to hold the cage, inasmuch as their retarding action may allow time for a safety catch to come into action; although there are very few cases in which the braking action will extend over a sufficient distance to absorb all the momentum, or even sufficient of it to prevent the breaking of the rope.

(4) Catchbeams in the headgear, which are in very general use in the Dortmund District, are almost unanimously approved by mine officials. In case of overwinding, the levers arms of these appliances automatically fall towards into the compartment after the cage has passed upwards, and afford a stop or bar which surely holds it against descending.

(5) Rope-detaching appliances should be used only when it is impossible to employ simpler means, such as converging guides, etc.

(6) The weakest parts in a rope which has been in use for some time are: (1) near the coupling; and (2), between the drum and the pit-head sheave when the cage is at the bottom of the shaft.

(7) The regulation safety factor of 6 is deemed sufficient.

(8) Taking the period of 1890 to 1902, the various safety catches in use in the district acted successfully on 126 occasions, acted 37 times when not required, and failed to act 54 times. Several of the last mentioned cases were due to the neglected condition of the catches, shafts, and guides.

Regarding the compulsory use of safety catches, the Dortmund Commission (without ignoring the fact that no safety catch yet produced is infallible, on the ground that the proportion of success to failure during the above period of 12 years is as 24 to 12, and that there is no case on record of personal injury due to the action of safety catches) is in favor of their retention until statistics prove that they cause more accidents than they prevent, subject, naturally, to their being kept in perfect order and having the springs frequently and periodically renewed. Furthermore, the guides should be of sufficient strength and section and should be regularly inspected. As the most effective way of preventing untimely action when hoisting minerals, the catches should then be put out of gear if practicable.

28. The reports referred to have been at the disposal of the members of this Commission, and have been of assistance in keeping the present investigation within reasonable bounds by the elimination of questions that had been already quite settled, and thus emphasizing the importance of the undecided factors.

29. In the report which follows, the subject matter has been treated as far as possible in accordance with the classification adopted in Schedule 2.

Winding Ropes (Structure).

30. The Commission has been especially fortunate in securing the testimony of a large number of prominent manufacturers of winding ropes; and their opinions with one exception, are all in favor of the use of "Lang's" lay ropes for winding in shafts where the conveyance is guided, i. e., kept from swinging and rotating. One manufacturer, while favoring "Lang's" lay for general use, states that ordinary lay is better for small drums, because a larger number of wires, and therefore smaller sized, may be used in the strands; in "Lang's" lay the wires would tend to untwist. Apart from the evidence of manufacturers, two American engineers were in favor of the ordinary lay for all cases. Locked-coil ropes are recommended by one manufacturer, but their suitability for the conditions obtaining in Transvaal mining operations is not considered to have been established.

That the deterioration of a winding rope should be susceptible to detection by a competent person, while making the customary examination, is a most essential point; and, although this can never be absolutely secured, it is considered that the rope constructed of six strands of seven wires each lends itself most readily to complete examination. It is also the most easily spliced, besides

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*The reader will note that the numbering of the paragraphs (which we have retained as in the original report, inasmuch as cross-references are made later by means of the numbers) begin with 18. The first 17 paragraphs of the report form the prefsce, which we give below rather than at the head of the text. "Your Excellency," referred to in the preface, is the Right Hon. Earl of Selborne, Governor of the Transvaal, who appointed the Commission on March 8, 1905. The preface follows:

1. The Terms of Reference to Your Excellency's Commissioners were more especially to inquire into and report on the following matters:

(I.) Winding Ropes.

(II.) Safety Catches and Safety Appliances Suitable for Winding Operations.

2. In view of the comprehensive character of the Terms of Reference, it was considered essential to seek and admit full oral and written evidence from those competent to give it, not only in the Transvaal but in all countries in the world where mining work is carried on.

3. It therefore became necessary to indicate to the public the points upon which the opinions of witnesses were to be invited. This was done by means of schedules, setting forth the subjects of the inquiry.

4. Schedule No. 2, of which no less than 4,000 copies were distributed throughout the world, contained a most detailed classification of the points concerning which the Commissioners desired the opinion of witnesses, and elicited valuable information.

5. Through the medium of His Majesty's Ambassadors in Germany, Austria, Russia, France, and Belgium, numerous communications were received from these countries, especially in respect of the mining regulations referring to the safety of persons traveling in shafts.

6. The witnesses were either invited to give, or, in response to advertisement, proffered their evidence. They represented the views of wire-rope manufacturers, engineers, mine managers, engine drivers, riggers, wire splicers, miners, etc.

7. Except in two instances, all practical tests of safety appliances were held on the property of the Langlaagte Estate and Gold Mining Co., Ltd., at the Marcus Shaft, which was kindly placed at the disposal of the Commission on the agreement that the cost of equipment, and of damage done, would be reimbursed to the company.

8. In view of the possibility of safety devices for use in inclined shafts being submitted to the Commission for trial, an examination of the Central Inclined Shaft of the Bantjes Consolidated Mines at Florida was made on Dec. 14, 1905, by Mr. W. Martin Epton (Inspector of Machinery) and Mr. C. J. Price. They reported that the center compartment of the shaft and the hoisting plant, engines, boilers, etc., appeared to be in good order and could be put into working condition at very little cost. As, however, no safety catch suitable for use in inclined shafts was recommended by the Sub-Committee for trial, it was not found necessary to make use of this shaft.

9. Under Executive Council Resolution No. 1,468 of 1904, the sum of £2,000 was granted for the practical testing of such safety appliances as the Commissioners considered worthy of trial.

10. The Commission consisted originally of 23 members, all technical men, who served in an honorary capacity.

11. During the course of the inquiry, three of the Commissioners, namely, Messrs. G. B. Poore, R. M. Catlin, and F. Drake, resigned in July, 1905, January, 1906, and July, 1906, respectively, owing to their permanent departure from the Transvaal; and Mr. K. Schweder resigned in February, 1907, as he had invented and was exploiting a safety catch and did not, therefore, consider it desirable to continue to sit on the Commission. Mr. J. A. Hebbard was appointed to take the place of Mr. Poore, but the other vacancies were not filled, in view of the fact that 15 members formed the necessary quorum.

12. Mr. Schweder continued to place his services at the disposal of the Commission, and his contribution on the subject of the safety catch designed by him is included in this report.

13. In February, 1906, the Chairman proceeded on long leave to England, and was absent for seven months, during which period Mr. J. A. Vaughan acted as Chairman.

14. Of the four sectional committees which were formed to consider more particularly the sub-divisions of the Terms of Reference, that dealing with the consideration of safety appliances was constantly at work. Eighty-four designs which complied with the Commission's requirements, as published in Schedule 2, were thoroughly considered; and many of the better designs were reconsidered several times. Many crude designs, which did not comply with instructions, were not formally brought before the Committee, but, in addition to the ideas of a great number of possible inventors who called on the Secretary, were considered and advised upon by Mr. J. A. Vaughan.

15. It was a condition imposed upon all inventors and others who submitted models that such models were to remain the property of the Transvaal Government. Many interesting and clever models have been received, and are stored at present in the offices of the Mines Department, Johannesburg.

16. The Commission desires to place on record its appreciation of the valuable assistance of Mr. Max Baumann of the New Rietfontein Estate Gold Mines, Ltd., for his excellent translations of the most important German communications.

17. The first sittings of the Commission and of the Committees were devoted entirely to matters of procedure and to the preparation of the schedules. The first public sitting was held on March 21, 1907. There have been many unavoidable adjournments, owing mainly to the nature of the work of the Committee on Safety Appliances, and to the practical tests at the Langlaagte Estate Mine, which have delayed the preparation of this report.

which a more even distribution of the working load over all the component wires is assured than is the case with ropes of other constructions. The center wire of the strand may not be thoroughly effective, but that it adds to the strength of the rope when made of high-grade steel has been established by many tests.

The limitation to the general use of the 6.6.1 rope lies, of course, in the fact that the wires for big breaking loads would become of too great diameter. Its use in the medium sizes (1-in. and 1⅛-in. diameters) on these mining fields has been discountenanced on account of the many small-sized winding drums, and the fact that the ratio of D to d—i. e., the diameter of the drum to the diameter of the wire—becomes less than 800 to 1; but there have been many instances of the 1⅛-in. diameter ropes of 6.6.1 construction giving most satisfactory results when winding on drums of less than 8-ft. diameter.

It may be stated with some certainty that the bending stresses to which winding ropes on the Rand are usually subjected constitute, save in exceptional cases, quite an unimportant factor in limiting their lives. While there have been cases of ropes used on sheave hoists giving out through the breakage of many numerous undivided wires, owing to excessive bending, it is more usual in drum hoists for frictional wear or crushing stresses to be the most important deteriorating influence.

31. From statistics furnished by the Mines Department, the following information has been prepared showing the various kinds of winding ropes now in use in the Transvaal for raising and lowering persons; about 50% are used for rock as well:

Kind.	Number.
"Lang's" lay	416
Locked-coil	0
Many-stranded	2
Ordinary lay	5
Flat	4
Flattened strand	0
Total	427

Of the 416 "Lang's" lay ropes, the sub-division according to construction is approximately in accordance with the following table:

Construction.	Number.
6.1	189
8.6.1	85
7.5.1	69
9.6.1	33
9.3	17
8.5.1	13
12.6.1	7
9.5.1	2
9.4.1	1

32. It will be noticed that ropes of compound construction are largely used, and the reason for this practice may be seen in the following tabulation of the value existing for D:d at shafts where persons are raised and lowered:

Value of Ratio D : d.	Percentage of Total Number of Winding Ropes.
Under 500	4.6
500 to 600	6.6
600 to 700	12.9
700 to 800	16.7
800 to 900	19.8
900 to 1,000	17.5
Over 1,000	21.9
Total	100.0

33. Whether the working conditions disclosed above in the matter of bending stresses be considered favorable or unfavorable, the fact remains that the average winding rope has a far shorter life on the Rand than on other mining fields. This fact was agreed upon by many witnesses; and the reasons assigned were corrosive water in shafts, unfavorable mechanical conditions, lower initial factor of safety, and higher final factor of safety.

Leaving for a time the full consideration of these cases, and returning to the matter of the most suitable kind of winding rope, it remains to be noticed that ropes of ordinary lay have been used successfully for sinking purposes where a "dead" rope was required, as in the case of a bucket or kibble being used. The spinning of the conveyance can then be prevented, but the swinging effects may still occur; and these effects have been so dangerous at greater depths that sinking by means of a skip with extension runners has been resorted to. A great deal of evidence was taken dealing with the relative safety of sinking by means of a skip or sinking with a bucket, and this will be alluded to later.

34. Dealing now with the "lay" of the rope, it appears that most manufacturers endeavor to make the rope as "dead" as possible, consistent with flexibility. Regarding the circumference of the strand as one-third of the circumference of the rope, the practice is to vary between 2 to 1 and 3 to 1; i. e., if the length of the lay of the strands in the rope is 9 ins., the length of the lay of the wire in the strands will be from 4½ ins. to 3 ins., according to the particular maker's practice. Most manufacturers keep more nearly to the 2 to 1 rule, but the manager of one large and important factory considers, after repeated experiments, that the 3 to 1 rule is the best, this bringing the angle of the lay of the strand in the rope exactly the same as that of the wire in the strand. This rope, while flexible, is very "dead;" and this practice permits of small ropes with very fine wires being constructed "Lang's" lay, which, as previously stated, is otherwise impracticable, as they would become untwisted as soon as they were cut.

Other ways of constructing a "dead" rope, besides "ordinary lay" and "locked-coil," are "flattened strand," "many-stranded," or by having the wires of the core of the strand twisted in the contrary direction to the outside wires of the strand. Of all these methods, the ordinary lay seems the least open to objection, the wires being all circular and well locked together. Compared with "Lang's" lay, and considering that the wires at the crown of the strand are set practically parallel to the axis of the rope, and also that an individual wire comes to the crown just twice as frequently as in the "Lang's" lay rope, broken wires should be of more frequent occurrence; but, on the other hand, the fractures will occur at places where their detection is the most easy matter, and their weakening effect is probably less owing to the more complete locking of the wires. So that if "Lang's" lay cannot be used on account of its untwisting, then ordinary lay appears to be the next best.

35. With reference to the "many-stranded" ropes in use on the Rand, the experience of their working is at the present time too short to enable it to be decided whether they will outlast the usual makes of winding ropes. The construction is 12 strands around 3 strands. The outside strands are made up of 4 wires around soft wire, and the inside strands are each composed of 3 wires around a hemp center. This rope does not rotate. The inner and outer portions of the rope are each "Lang's" lay, but one is left-handed and the other right-handed.

36. Regarding the core of the strand, as far as the evidence adduced goes, if this is made of hemp the strand is unable to keep its shape under heavy pressure such as a winding rope is subjected to, unless wound on the drum in only a single layer. So long as the strand keeps its shape and the bedding of the outer wires remains close, the hemp core, well-dressed initially, may materially assist in preventing internal corrosion; but when deformation occurs, water finds its way inside the strand, the hemp gets "chewed up" and washed out, and the conditions are then exceptionally favorable for internal corrosion.

37. With regard to steel cores, the weight of opinion is against any specially shaped core—triangular or tape—it being considered that these are likely to nick or cut the wires that rest on them. That the core wire should be circular is generally agreed, but there is great difference of opinion regarding the tensile strength of steel that should be used. The most modern practice appears to be to use a class of steel similar to, or at any rate but slightly lower in tensile stress than, that of the outer wires. The tests in the Mines Department Laboratory conclusively prove that a hard-core wire does add materially to the strength of the rope, and experience of the examination of many samples goes to show that these core wires are no more liable to fracture than those made of annealed steel or iron. Steel core wires, whether soft or hard, whether broken or not, help to maintain the shape of the strand, and local evidence points to the advantage of using wire of high tensile strength.

38. In spite of Professor Hrabak's condemnation of the wire center on theoretical grounds, this Commission considers it quite unproved practically that the hemp core is superior.

39. With respect to the question as to what proportion of strength can be assigned to a steel wire core in the strand, this can only be answered correctly after examining the records of many more tests than have been undertaken up to the present; but it may be remarked that so long as the strength of the rope is ascertained by actual test of a whole specimen of adequate length, no uncertainty can exist on this point, the combined efficiency of the wires being then exactly determined.

40. The main core of a winding rope should be of the best hemp or manila, of good long yarn, laid up to form a tight rope, well soaked in boiling tar and treated with some non-acid lubricating composition. No tensile strength can be expected from this hemp core, but it should be made up tightly enough to form a firm center that will keep the strands in place and the rope in shape under a considerable crushing pressure, such as exists when the rope is coiled in several layers (riding turns) on the drum. Cases were brought to the notice of the Commission in which the fiber core consisted of untarred jute, of short yarn and unlubricated. A rope with a core of this description, when working in a wet shaft, has but a very short life, the jute becoming washed out and the rope flattening and having its lay straightened out in places. The engineer, having then no confidence regarding the even and fair distribution of the load among the component wires of the rope, takes it off; that is, unless the damaged portion can be cut off the end of the rope and still leave a sufficient length.

41. When a rope of compound construction is used, the outer wires should be of as large gage as possible consistent with the size of the drum and sheave. Between the limits 6.1 and 12.6.1, in each of which constructions the wires are of the same size, there are many variations—such as 8.6.1 and 7.5.1—in which the outer wires are larger than the inner ones. Ropes made up of these strands have larger wearing surfaces to meet friction and corrosion.

42. It appears possible to construct parallel ropes of great length without any break in the continuity of the wires. Many manufacturers, however, appear to regard this as quite an unnecessary refinement, and join shorter lengths of wire together by brazing. The brazed joints in the various wires should, as far as possible, be so arranged that they are not too nearly adjacent. The braze is made on a taper about five to seven times as long as the diameter of the wire. The heat necessary for the operation softens the wire somewhat; so that although the actual joint may be stronger than the wire in tension, breaks often occur when the rope is in use at distances of from an eighth to a quarter of an inch from the braze.

43. Manufacturers differ considerably as to the best method of constructing a tapering rope. The plan most favored is to keep the same number of wires in the strands for the whole length of the rope, and to make the taper by brazing on, at each step, wires of slightly smaller diameter, keeping the joints of the several wires widely distributed. The other plan is to drop out wires from time to time; for instance, one sample of tapered rope of compound construction had strands of 12.6.1 at the large end, 11.5.1 at the next step, 10.4.1 at the next, and 9.3.3 at the last stage, the innermost three wires being very fine ones put in merely for packing. In this method of construction the outer wires are of uniform section throughout, as are also the inner wires. This is claimed as an advantage, especially for use with conical drums where, if the wires are not of the same size, they will be too large for use on the small end of the drum or of too fine a gage for the large diameter. On the other hand, some of the advocates of brazing regard the older practice of dropping wires as dangerous.

44. The perfect method of constructing a taper rope would be to lay up tapering strands of tapering wire, but at the present time it is practically impossible to draw such wire. The tapered ropes at present supplied to the mines on the Rand number only two, and only one of these has been put into use. In view, therefore, of this limited experience, the Commission is not prepared to express any preference; but it does not condemn the practice of dropping wires, which may be regarded as quite safe if properly carried out.

Winding Ropes (Material).

45. The various grades of steel used in the manufacture of winding ropes are designated in an arbitrary and somewhat misleading fashion. Such terms as "improved patent crucible," "best patent crucible," "mild," "best," or "improved plow," are used by many makers, but not as denoting any exact standard of tensile strength.

46. The fundamental difference between so-called "crucible" steel and "plow" steel is that the iron bases used in their manufacture are not the same. Plow steel is made from a base of the finest quality, and crucible steel from some cheaper iron, these two varieties being represented respectively in English practice by "Swedish" and "Cleveland." The Siemens-Martin process is used, either acid or basic. In the basic process a low-grade iron may be used, possibly highly phosphoric, while the acid process is suitable for the higher grade only.

Other differences between "crucible" and "plow" steels are the outcome of manufacture—e. g., the heat treatment, and the number of passes through the dies. Continued drawing will increase the breaking stress of a wire. The lower the quality of the iron from which the steel is made, the quicker will this steel harden up—i. e., the fewer draws will it require. The heat treatment, or tempering process, is introduced to give toughness to the wire, and not to increase the tensile strength. Owing to the fact that the manufacture of high-grade wire is practically a secret process, it has not been possible for the Commission to get anything more than the barest information.

47. It is known with certainty, however, that wires which are called the same, and which test the same, are yet very different in price, and give very different results in use, especially when the working conditions are severe. The tests alluded to here are the old-established chemical and mechanical tests. In the chemical test, carbon, silicon, manganese, sulphur, and phosphorous are first determined, and the amount of iron is then arrived at by difference. From the results of recent researches, it appears that hydrogen and nitrogen exist in steel and deleteriously affect the quality, so that the complete ignoring of these elements is no longer possible.

In the mechanical test, steel wire is tested as to its ability separately to stand tension, torsion, and bending. Recent investigations have shown, however, that wires in reality of poor quality, and which still come well up to the standard of these tests when conducted separately up to breaking load, have had their inferiority disclosed by means of combined tension, torsion and bending tests rapidly repeated in a manner

which closely resembles working conditions at stresses below the elastic limit of the material.

48. A drawing and description are shown here of a machine designed by Messrs. Vaughan and Epton, for the purpose of testing wires in this way.

49. With regard to the ductility—i. e., the non-brittleness—of the finished wire after the drawing and heat treatment, this depends on the care and skill exercised, as also on a knowledge of the drawing steps and limits suitable for the particular class of steel used. With this qualification, it may be stated that ductility is not sacrificed in the gain of tensile strength. Seeing, however, that the large majority of rope manufacturers purchase the finished wire, they are not in the best possible position to apply the results of experience gained as to the working life of various qualities.

Mr. J. Dixon Brunton, of Musselburgh, kindly furnished the Commission with a copy of his paper, "The Heat Treatment of Wire, particularly Wire for Ropes," which gives the result of research work undertaken with the view of ascertaining the correct heat treatment of wire. The following is an extract of his conclusions:

It will be seen that a somewhat simple method has been reached whereby a manufacturer can determine the correct amount of carbon which his steel should contain to produce a certain maximum stress in the finished wire; and at what point the process of reduction should cease, so as to get the most useful amount of work out of the finished rope.

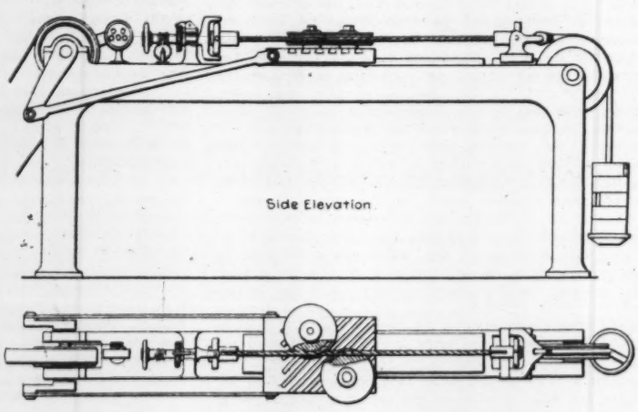
Further, the experiments show that it is possible to increase the specific gravity of steel from 7.768 to 7.998 by cold working, and that when it reaches this point and is again subjected to a crushing action by pulling through a die, as in wire-drawing, it actually gets lighter, showing that it is impossible by this means to make it more dense.

It must be borne in mind that the results here given probably will not apply to steel made by different processes and of different chemical compositions.

Further, the results show that the usual methods of obtaining the best wire by means of torsion and tensile tests are not altogether trustworthy for determining the best point for the wire to perform useful work.

50. For winding ropes on the Rand, manufacturers recommend steel wire of an ultimate stress of 105 to 135 short tons,* and it appears that 120-ton steel is most commonly used. The lower and higher limits are advised for working conditions, as regards bending stresses, either unfavorable or very favorable. There are cases in which 150-ton material has given quite satisfactory results.

51. The experiments with nickel steel and vanadium steel for winding ropes have not proved successful, and no manufacturer appears to be able to recommend these alloys.



ROPE-TESTING MACHINE INVENTED BY MESSRS. J. A. VAUGHAN AND W. MARTIN EPTON.

The machine is constructed to subject the specimen simultaneously to tension; to intermittent flexure through any desired angle and restraightening, with or without reversed bending, applied successively over a substantial portion of its length; to friction upon pulleys, and also, if desired, upon itself; and in some cases also to torsion. It is suitable for testing single wires or strands.

There is a main framework, a fixed headstock, and a tailstock freely movable longitudinally on the table upon a guide. The specimen is held in grips of any convenient construction, secured to the stocks by universal joints such as the gimbals illustrated. The purpose of these connections is to obviate bending of the specimen at the mouth of the grips.

Tension is applied to the specimen by means of the adjustable weight, connected to the tailstock by a flexible connection which passes around an idler pulley. The means for applying and indicating the tension may be modified according to the size of the specimen which the machine is designed to test.

To enable the specimen to be twisted, the head gimbal has a journalled shaft which rotates in the headstock and is secured therein by a collar. To the shaft is keyed a hand wheel for rotating it, and a detent and detent wheel are provided to hold the shaft in the desired position. An indicator shows the angle through which the specimen has been twisted.

A table, mounted upon a suitably constructed guide, slides freely in a longitudinal direction upon the frame. The upper surface of this table has a number of undercut grooves by which one or more grooved pulleys may be secured to the table at any desired point. About such pulley or pulleys the specimen is passed as may be desired for any individual test. In the plan two pulleys are shown, and the specimen is passed around each one in succession.

52. The effect of galvanizing "plow" steel wire and the amount of protection which this treatment affords, even when some of the coating has been broken, has been investigated locally by Mr. W. M. Epton and Dr. Moir. Their experiments go to prove that: (1) the ultimate tensile strength is not lowered, while the elongation is doubled; (2) the capacity to resist torsion is reduced 20%; (3) the capacity to resist bending is reduced 25%.

The protecting power of galvanizing, even when the surface of the steel is not wholly covered as would be the case in a worn winding rope, is shown [illegible] presented by Mr. Epton and printed on page [illegible] the Minutes of Evidence. The corrosion of partly-[illegible] wire proved to be only about one-eighth of that [illegible] wire with the same surface exposed. It must [illegible] however, that the wires experimented with were [illegible] of the ordinary commercial quality, as the experi[illegible] prepared their own samples by dipping.

53. With respect to galvanized winding ropes [illegible] are divided; but the weight of evidence is against [illegible] them. Galvanized ropes have given good results [illegible] upcast shafts; but if the water is acidulous, it [illegible] that brittleness may result in the wire owing to [illegible] action and the formation of hydrogen. Experi[illegible] carried out in the Mines Department Chemical and [illegible] chanical Laboratories, however, go to disprove this [illegible] tention.

54. The following extract and table are taken [illegible] the proceedings of The Transvaal Institute of Mechanical Engineers, March 10, 1906:

Reply to Discussion on the paper read by Messrs. J. A. Vaughan and W. Martin Epton on "Wire Ropes used for winding: their strength and some causes of its reduction."

The authors are more than glad that they had the temerity in their paper to introduce the chemical aspect of rope deterioration. No misconception appears to have arisen owing to the step—the chemists have come forward with alacrity to assist in the inquiry, and they have attacked each other, and not the writers.

The interesting experiments of Mr. Heymann go to show that even the most acid mine water has very little more corrosive action than plain water, and that the primary cause of the corrosion of the wires of winding ropes is contact with air or deleterious gases. This is a most important point, in that it allows of experience gained in Great Britain with respect to the efficiency of galvanized wire rope to be referred as holding true for the Transvaal. Dr. Moir's experiments have entirely disposed of that bogey, which was always a scientific fallacy, viz., that during the life of a galvanized wire rope, when the zinc was worn off in places the galvanic action would then lead to more rapid wasting of the steel.

Through the courtesy of Messrs. Allan, Whyte & Co., Dr. Moir and the writers have been able to repeat the experiments, the results of which were previously published, dealing with the effects of galvanizing as a preservative and as a deteriorating agent with respect to the ductility of the steel. The samples forwarded represented identically the same wire, plain and galvanized, so that an exact comparison was possible.

The accompanying table shows the results obtained. The method of preparation of the specimens for the chemical test was the same as previously described by Dr. Moir. It is evident that a coating of zinc has a protective action on steel, even when the latter is exposed to the acid. Generalizing, results show that plain wire suffers about 30 times as much corrosion from fairly strong acid as the same wire does when it has a coating of zinc near the exposed surface of the iron, and about ten times when the acid is weak.

The galvanizing in these instances was, of course, of the ordinary commercial character, and not home made as in the case of the previous experiments; the reason for repeating the tests being that the latter improvised method of galvanizing had, it was suggested, possibly spoiled the wire.

The effect on the ductility, and on the other desirable qualities that the hard-drawn steel originally possessed, is fairly clearly set forth in the tabulated results. The elongation is increased nearly 100%; while the tensions and bendings obtained are reduced, the former rather less and the latter in a rather greater degree than was anticipated from the results recorded by previous investigators.

The difference in tensile strength between galvanized and non-galvanized wires amounted to only a very small percentage. If you take the actual area of the wire, counting in the thin coating of from 0.001 in. to 0.002 in. of zinc on the outside, it shows really a moderate reduction in tensile strength; but where you figure it

*Unless otherwise specified, all "tons" referred to in this report are tons of 2,000 lbs. each.

TABLE SHOWING RESULTS OF TESTS CONCERNING THE EFFECT OF GALVANIZING ON WIRE ROPE.
[Tests by Messrs. J. A. Vaughan and W. M. Epton.]

	Tests in Chemical Laboratory.					Tests in Mechanical Laboratory.			
No.	Strength of H_2SO_4.	Time of exposure.	Loss of Iron (gms. per sq. in.)	Remarks.	Conclusions drawn from Chemical Test.	Diameter and Description.	Breaking Load in lbs.	Percentage Elongation.	No. of Torsions in 8 ins.	No. of 180° Bends over ¾ in. Radius.
					Improved Plow Steel.					
1	0.071% at 66° F.	49 hrs	.0481	Plain	This acid is about five times as strong as most mine waters, and had dissolved most of the zinc coating.	.080 in. plain	1,200	3.1	38	9
			.0018	Galvanized		.083 " galvanized	1,220	6.9	32	7
			.0476	Plain						
			.0014	Galvanized						
2	0.025% at 70° F.	21 hrs.	.0081	Plain	Acid in thin layer just covering wires in a flat dish. Practically same results as in No. 4, therefore contact with air makes no difference.	.092 in. plain	1,580	3.4	36	9
		21 "	.0009	Galvanized		.095 " galvanized	1,620	7.5	29	7
		43 "	.0231	Plain						
		43 "	.0033	Galvanized						
					Mild Plow Steel.					
3	0.071% at 67° F.	48 hrs.	.2255	Plain (not aerated)	Aeration has therefore very little effect on the corrosion. This wire is much more easily attacked than No. 1.	.103 in. plain	2,020	4.4	31	7
			.0079	Galvanized "		.105 " galvanized	2,000	7.8	24	5
			.1972	Plain (aerated)						
			.0094	Galvanized "						
4	0.025% at 68° F.	43 hrs.	.0097	Plain	Zinc apparently unaffected.	.092 in. plain	1,560	3.7	37	8
		43 "	.0011	Galvanized		.096 " galvanized	1,640	7.5	29	6
		66 "	.0231	Plain						
		66 "	.0067	Galvanized						
5	0.071% at 66° F. with ferrous sulphate added.	48 hrs.	Not measured, owing to added iron.		A much more marked corrosion resulted in the unprotected wires, but the galvanized ones were little attacked, although they lost most of their zinc.	.080 in. plain	1,160	3.4	40	11
						.083 " galvanized	1,180	7.5	32	8
					Special Improved Patent Crucible Steel.					
6	0.025% at 70° F.	21 hrs.	.0108	Plain	This wire is more easily corroded than Nos. 1 or 4.	.103 in. plain	1,540	3.7	30	7
		21 "	.0009	Galvanized		.105 " galvanized	1,660	7.5	24	6
		44 "	.0151	Plain						
		44 "	.0021	Galvanized						

on the actual area of the steel, there is really no appreciable reduction. The figures are a bit variable. We obtained in one case 1,200 lbs., as against 1,220, the breaking load of the wire—the 1,200 being ungalvanized and the 1,... galvanized. The makers at home get 1,210 and 1,215. Unfortunately, Mr. Epton, who actually carried out the tests, is away; but I am certain of this, that he was convinced in his own mind that there was practically no reduction in tensile strength at all.

55. The Commission considers galvanized wire ropes worthy of trial in cases where ordinary ropes suffer rapid corrosion.

(To be continued in our next issue.)

THE TWELFTH GENERAL MEETING OF THE AMERICAN ELECTROCHEMICAL SOCIETY.

The home of the Chemists' Club, at 108 West 55th St., New York City, was the general headquarters for the twelfth general meeting of the American Electrochemical Society, held on Oct. 17, 18 and 19; hotel headquarters were at the Cumberland, 54th St. and Broadway. The first of the Society's activities did not begin until 7 p. m., on Thursday, Oct. 17, when the Board of Directors held a meeting at the clubhouse. At 8 p. m. a reception was held in the lecture hall of the club, and at 8.40 p. m. a technical session was called, also in the lecture hall.

The features of this session were two illustrated lectures, which were unique in that they covered the two extremes in the carbon series: Dr. George F. Kunz, the well-known gem expert of Tiffany & Co., and formerly of the United States Geological Survey, gave an address on "The Diamond and Moissanite; Natural, Artificial and Meteoric"; and Mr. E. G. Acheson, President of the International Acheson Graphite Company, of Niagara Falls, gave a lecture with demonstrations and experiments on "Deflocculated Graphite." An article on the latter subject by Mr. Acheson appeared in "Engineering News" for Aug. 1, and his lecture was quite similar to that article, with, of course, the addition of demonstrations, and some amplification.

Dr. Kunz, in his talk on the diamond, covered all phases of that mineral, from the black "bort" used in diamond drills to the valuable blue-white gems used as ornaments, and even the exceedingly rare blue and green diamonds. For the utilitarian side of the diamond he mentioned a bore hole which had been driven 5,600 ft. with an American drill manufactured in Chicago; and in regard to meteoric diamonds—not a generally known commodity—he mentioned a mass of meteoric iron found in an iron mine in Arizona, which weighed 1,680 lbs., and contained a number of diamonds. In this connection he exhibited a diamond, the first ever polished with dust of diamonds from interstellar space.

Prof. Moissan's noteworthy experiments for the production of artificial diamonds were referred to at some length by Dr. Kunz, and the artificial stones—silicide of carbon, with a hardness of 9 to 10—Dr. Kunz himself has named Moissanite, in honor of the man who produced them. In the course of his talk Dr. Kunz referred to carborundum, in the first production of which Mr. Acheson was very active, and said in regard to its hardness that it would cut anything but a diamond, and therefore that a scratching test with carborundum was a tolerably reliable test in case stones that have been found are suspected to be diamonds.

Taking up the other end of the carbon series, Mr. Acheson exhibited his now fairly well-known amorphous or colloidal carbon—not to say molecular—which he has christened "deflocculated" graphite. It is unnecessary, of course, to go into detail in regard to Mr. Acheson's address, in view of the article which we have published on the subject. There was little discussion of either of the two papers of this session, although considerable interest was shown by the members in the stereopticon views of primitive and modern diamond-mining methods shown by Dr. Kunz; he also had a case in which were glass models of some of the world's most famous diamonds in the uncut form, as they were found.

The next technical session was called at 9 a. m. on Friday, Oct. 18. A paper was presented by Mr. Albert E. Green, of Herault, Cal., on "The Electrothermic Reduction of Iron Ores." Dr. J. W. Richards, of Lehigh University, Secretary of the Association, presented a discussion of the "Electric Furnace Experiments for the Production of Pig Iron at Sault St. Marie." The first of these was interesting in view of recent developments in electric furnace iron production in California, and the second was fully as interesting. There was little discussion of these papers. Dr. H. N. Potter, of New York City, presented a paper on "Electric Furnace Experiments," the paper concerning mainly the reduction of silicates and the products derived thereby. Dr. Potter presented a further paper in this direction at the next morning's session, which we shall note later.

Mr. A. B. Albro, of New York City, presented a paper on "The Analysis of Silicon Compounds." Dr. Richards then read in abstract a paper by Mr. Oliver P. Watts on "The Metals in Order of Their Boiling Points, as arranged from Moissan's Electric Furnace Experiments;" this paper covered experiments in the electric furnace on the following alloys: copper and lead, copper and tin, gold and copper, gold and tin, silver and copper and silver and tin. From these experiments on combined metals, deductions were drawn relative to the boiling point of individual metals; the criticism was afterwards brought out in the discussion that it was hardly accurate to make determinations of the relative volatility of metals from the volatility of alloys of which they were components.

Mr. C. E Baker, of Cleveland, described "A New Application of Chlorine in Metallurgy"—a paper of considerable practical value, in that it described a process for the reduction of refractory ores, mainly sulphides, by a method which eliminates the objectionable throwing off of sulphurous gases. The usual method in treating sulphide ore is to use the sulphur as a fuel, as in pyritic smelting, or by its combustion in roasting to oxidize the metal or to convert it into a chloride by roasting with NaCl. In either of these processes the sulphur is lost, and the surrounding atmosphere is rendered obnoxious by the poisonous gases given off, with resulting damage to vegetation, consequent law suits and general public objection to the process. Mr. Baker's process is one in which dry chlorine gas is generated and used direct, to convert the existing metallic sulphides into chlorides. The main point brought out in his paper is the cheapness of the chlorine used, the gas being obtained by the electrolytic decomposition of common salt and on a successful commercial basis. Briefly, the finely pulverized and practically dry ore is placed in a porcelain-lined tube mill provided with flint grinding pebbles. The free chlorine is admitted to the tube mill, with suitable precautions against the escape of the gas, and the drum is heated. The chemical reactions within the drum generate additional heat, which facilitates the process. In the presence of the heat sulphur chloride is formed, which at 150° C. is expelled as a gas and may be condensed. This by-product is of more value than sulphur alone, being salable at 10 cts. per lb., and in the production of the chlorine gas a by-product of caustic soda is obtained. Therefore, Mr. Baker states, the cost of the chlorine gas for use in the process is more than offset by the value of the by-products. Further, in Mr. Baker's paper, he rather categorically says, "Cut out smelting, roasting and concentration, and replace them with chemical and electrochemical methods. Chlorine is the element of the work, either as such or as the active element of hydrochloric acid or other chlorides." There is food for thought in this statement, for mining and milling men, with the possible development of some interesting discussion between them on the one hand and electrochemists on the other.

Prof. C. L. Speyers, of Rutgers College, asked the question of Mr. Baker how he regulated the action of the chlorine so as to prevent the gold from going into solution. The answer given was that in the presence of ferrous chloride—iron being largely present in gold and silver-bearing ores—gold will not go into solution, but will remain free.

Mr. F. A. J. FitzGerald, of Niagara Falls, presented a paper on "The Heat Conductivity of Carbon." This paper was largely speculative in character and could not be said to have brought out positively any definite facts, being mainly notes on experiments tending in the direction of concrete facts.

A paper by Mr. W. R. Mott on "Electrochemical Methods for the Qualitative and Quantitative Determination of Free Silicon in the Presence of Silica, Silicates, Oxides, Free Carbon and Carborundum," in the absence of adequate time was read by title, when the Society adjourned to the Hotel Cumberland for dinner. From there the members went in a body to Orange, N. J., to visit the laboratories of Mr. Thomas A. Edison. Mr. and Mrs. Edison personally received the guests in Mr. Edison's library, and after an informal reception a tour of inspection of the laboratories and the phonograph plant was made, Mr. and Mrs. Edison and his heads of departments each conducting small parties.

A great amount of work is being done by Mr. Edison in the development of his new nickel-iron storage cell, and a great deal of space is given over to elaborate efficiency and endurance tests. The battery has not absolutely proved itself so far, but it may be mentioned that the trucks which convey material about the grounds are driven by batteries of that type.

Considerable interest was manifested by members of the party, and *particularly* by newspaper reporters in attendance, in a model of a three-story house in one of the laboratories, which model is one of the steps in the development of a remarkable project to build concrete houses for workmen at the rate of three days to a house and at a cost of $1,000 per house, the idea being that a cast iron matrix or mold will be set up and the house *poured complete from the top.*

Returning from this excursion, most of the members partook of a banquet at the Liederkranz Club.

The last technical session of the convention was held at 9 a. m. on Saturday, Oct. 19, in Earl Hall at Columbia University. Papers presented at this session were "Electric Furnace Experiments" (second paper on the same general subject), by Dr. H. N. Potter; "Granular Carbon Resistors," by Mr. S. A. Tucker; "The Electrolytic Theory of the Corrosion of Iron" (with demonstrations), by Dr. Allerton S. Cushman, and "Electrolytic Determination of Minute Quantities of Copper," by Mr. Edward E. Free. By title only, there were presented "Action of Ammonium Persulphates on Metals," by Mr. J. W. Turrentine; "Electroscopic Determination of Radium in Some Tufa at Hot Springs, Arkansas," by Mr. Herman Schlundt, and "Electrolytic Reduction of Nitric Acid," by Mr. H. E. Patten.

In Dr. Potter's second paper on "Electric Furnace Experiments," he described a compound designated as "monox." This is an amorphous, light brown and almost impalpable powder, which is a silicon monoxide, and seems to have as many uses and functions as the enchanted bag immortalized in the "Swiss Family Robinson;" not the least important of which, if the claims which Dr. Potter makes for it are substantiated under prolonged tests, is that of a body for corrosion-preventing paint in an ordinary linseed oil vehicle. Dr. Potter stated that iron and steel test pieces which were coated with "monox" paint resisted corrosion over long periods of time under severe conditions, and that the coating retained a varnish-like gloss over the same lengths of time. The results of some of Dr. Potter's tests seem to indicate that absolute opacity is an essential property in protective paints, in that opacity protects the metal beneath from the chemical action of the sun's rays. "Monox" as a paint body, Dr. Potter stated, possesses peculiar properties of opacity, in spite of its very light brown color.

Another property which "monox" possesses—although one not of such great interest to engineers—is that it improves the "laying" qualities of printers' ink. Dr. Potter showed some halftones which exhibited undeniable superiority, in the dead-black portions, over some others that were printed with ordinary commercial ink.

Dr. Cushman's paper covered the same general ground as did one which he presented at the last annual convention of the American Society of

Testing Materials in June. In our issue of Sept. 26, page 328, was given an extended abstract of this and other papers on that subject.

Saturday afternoon was devoted to two excursions: one to the new power plant of the Pennsylvania R. R. at Long Island City, and the Electrical Testing Laboratories at 80th St. and East End Ave.; the other to the plant of the U. S. Metals Refining Co. at Chrome, N. J., to inspect the processes of copper smelting, converting and electrolytic refining; and also the electrolytic refining of doré bullion.

Saturday evening the Chemists' Club tendered the delegates and guests a smoker at the clubhouse in 55th St.

THE USE OF THE T-RAIL FOR STREET RAILWAY TRACK IN CITIES.*

By C. GORDON REEL.†

In the horse car days the equipment was so light and speeds so leisurely that the problem of a proper track was easy of solution. It was expected that wagon traffic of all kinds would follow along the car tracks, and so city ordinances usually required that the street railroad companies make proper provision for the accommodation of vehicular traffic. With the introduction of electricity weights and speeds were increased enormously. The trend of development has been steadily to approach nearer and nearer to steam railroad standards. With the increase in weight of equipment and increase of speed the grooved and girder rail sections soon demonstrated their inability to carry the car traffic without rapid deterioration. The inefficiency of these sections was due not to the light weight so much as to their unscientific design. The vertical web of the rail was usually directly under the flange of the wheel, so that the weight of the car would be carried on a sort of projecting shelf. This unsymmetrical unloading was more than the rails could stand. They pounded down rapidly at the joints and could not be held to gage. Our companies were unfortunate enough to build with 7-in. grooved and girder sections, with a 4-in. base, and weighing 72 and 80 lbs. to the yard. These rails were structural wrecks at the joints long before they were worn appreciably.

In other cities similar sections have been used which overcome the inherent weakness in design by brute strength, so to speak; that is, they are rolled in weights up to 150 lbs. per yd., which would seem absurd to steam railroad men, especially in view of the very much heavier rolling stock used by the steam roads. It is self-evident that a proper section should not be inordinately heavy, and should carry its load with no tendency to moving sideways, and furthermore that the track should stand solidly in place without having to strap the rails together every few feet. All T-rails fulfil the first two requirements, but the standard steam railroad sections would seem to serve better than the high T-sections in regard to lateral stability. Just what is gained by using a high T is hard to understand, still I am willing to concede that, in view of the experience in some of the larger cities which use this rail, there is a chance for an argument between high T-sections and standard T-sections. Personally I would prefer to pay more per ton for standard sections than for high T-sections, although under ruling prices the high T costs considerably more per ton than standard T-sections.

When it became necessary to renew the tracks in Kingston, I looked over the experience of other companies and concluded that the T-rail was in every way more desirable than the grooved or girder rail, and proceeded accordingly. To make sure, we laid an experimental piece of track, using 90-lb. Am. Soc. C. E. standard rail. This gave such good results that we placed an order for several hundred tons in 60-ft. lengths, with a view to extending the construction. After the rails were delivered a bitter opposition was carried on both in the public press and in the State legislature, but the city finally gave its consent to lay T-rails in two rather important streets, with the stipulation that if, after the end of a year, the city authorities so desired we would remove them and substitute the old rails. As an instance of the unfairness of the opposition, this proposed trial was fought bitterly. They well knew that if the construction was tried it would make good.

Since the installation of this 90-lb. standard construction in the two streets referred to, we have been granted permanent permission without any restrictions to use this 90-lb. standard T-rail in the most important streets in the city. The opposition has simply made itself ridiculous, and is now considered a joke.

The first construction has been amended as shown in Fig. 1; that is, we are using a special form of brick outside the rail as well as inside. It will be noted that on the inside we will go up on the head of the rail to such a distance as to barely give room enough for our wheel flange. In this way the obstruction in the street will be much less than though the brick projected under the head of the rail and very much less than any form of grooved or girder rail. I might say in passing, however, that it is now standard practice to use only ordinary brick. On the outside the brick is merely laid flush with the rail, and on the inside it is tucked under the head as shown in Fig. 2, which illustrates the construction now standard in the streets of Milwaukee.

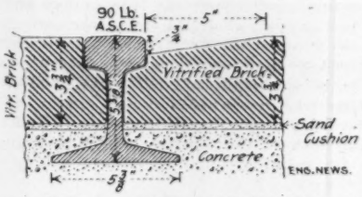


Fig. 1. Latest Construction in Kingston, N. Y., Showing Special Brick Outside of Rail.

The "Nose" brick extensively used heretofore has not been entirely satisfactory. By referring to page 684, Fig. 2, Engineering News, June 20, 1907, which illustrates the type of construction adopted in Fort Wayne, it will be noted that the designer desired a somewhat different form than the market provided. We think that the kind we are having made for Kingston, illustrated in Fig. 1, combines many desirable features. In the event of heavier flanges being used experience teaches that they will cut their own way in the brick and will not crack the pavement badly.

In regard to what standard section to use, we have found the 90-lb. Am. Soc. C. E. most desirable.

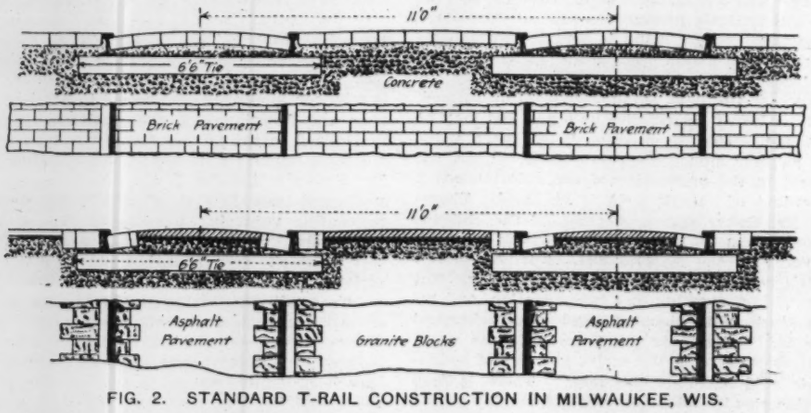


FIG. 2. STANDARD T-RAIL CONSTRUCTION IN MILWAUKEE, WIS.

The gist of the whole T-rail matter seems to be that street railway tracks are beginning to be built to serve the companies which build them and the patrons of these companies, rather than every Tom, Dick and Harry of a truckman who stubbornly insists on following the car tracks instead of staying out in the roadway where he belongs. If this driving along the tracks served any economic end it might be tolerated, but it does the truckman no good and interferes with the movement and comfortable transportation of countless thousands of more important people. It would seem absurd if it were not true that any one would argue in favor of having the tracks of a street railroad reserved for the transportation of merchandise at the inconvenience and discomfort of human beings.

The horse car, the wagon on the track, slow speed, light equipment, grooved and girder rails belong to the past. The electric car with the wagon in the roadway, high speed, heavy equipment on T-rails belongs to the present. If any man or body of men, either through ignorance or spite, endeavor to relegate any of you gentlemen to the past and, benightedly or wilfully, attempt to require you to continue grooved and girder rails in the face of present development, you will combat and overcome this ignorance and prejudice if you have a spark of manhood, and as "Angels of Light" will fight for and achieve T-rails, thus confounding these spirits of the Dark Ages.

*Abstract of paper read before the Atlantic City Convention of the American Street and Interurban Railway Association, Oct. 16, 1907.

†Vice-President, Kingston Consolidated Railroad Co., Kingston, N. Y.

MUNICIPAL READJUSTMENT OF LOT BOUNDARIES ON NEW STREETS, FRANKFORT-ON-THE-MAIN.

The uncontrolled natural growth of American cities and the haphazard way in which new streets are still laid out in undeveloped areas is well known to our readers. This failure to work to a general plan gives a queer look to the street map of most American cities. An attempt to improve upon this method, or lack of method, has been practised with considerable success in Frankfort-on-the-Main, as regards extensions of built-up areas, first through voluntary co-operation between the municipal authorities and lot owners, and since 1902 by means of set legal procedures and commissions appointed for the purpose. A description of the Frankfort operations is given in the interesting "Guide to Some of the Public Works" of that city, recently published by Herr Koelle, City Engineer.

Herr Koelle states that the population of Frankfort increased from 91,040 in 1871 to 288,989 in 1900. This increase gave rise to many problems relating to housing, the condemnation of unhealthy crowded quarters of the city, and the opening up of new building areas. The municipal authorities already had the right to acquire land for new streets by compulsory purchase, but on doing so the plots abutting on the new streets were often of such size and shape as not to be suitable for building purposes. Laws designed to remedy this state of affairs were already in existence in Hessen, Hamburg and Baden, Germany, and also in Switzerland, and in 1902 a somewhat similar law was made applicable to Frankfort. Herr Koelle's summary of the law and the operations under it may be quoted, with some curtailment, as follows:

The readjustment of the boundaries of land belonging to various owners for the laying out of the land for building purposes is necessary in the public interest.

Nursery gardens and parks may be exempted.

The readjustment takes place at the request of the municipal authorities or of more than one-half of the owners, provided the latter own more than half the area in question, apply for it.

The land required for the streets and open spaces is first deducted from the total area and the remainder is then divided among the owners in the shape of suitable building sites according to the extent of their property.

Each owner to receive his new building plots as far as possible on the same site, on which his property was formerly situated.

The owners are to receive a money compensation for the land taken from them for street and open spaces, if the latter exceeds 30% of the area of their property dealt with.

The value of the new building plots must be at least equal to the value of the original property, otherwise the owner must receive the difference in money. In a like manner must the owner be compensated in money for the dispossession of houses and nursery gardens.

The readjustment of the boundaries and the rearrangement of the plots is done by a commission consisting of at least six members. Two of the commissioners are nominated by the governor of the district, and among the other members there must be at least one well acquainted with building matters, one lawyer, one officially qualified surveyor and one other expert.

The commission determines the time during which the streets and open spaces for the traffic and for building thereon are to be made, and when the readjustment is made at the request of the municipal authorities this period must as a rule not exceed four years.

Although owing to the short period that has elapsed since its coming into force (Jan. 1, 1903) it is not possible to make here any statement in reference to the application of this law, ample experience nevertheless has been gathered in Frankfort o. M. in reference to the matters under review.

The efforts of the municipal authorities in the matter of opening out new building estates through the voluntary adjustment of the boundaries date back about a decade and have been successful—although in many cases only after very lengthy negotiations—to this extent that up to the end of 1903 an area of 104 ha (257 acres) has been opened out for building. It ought to be recorded here, that in all cases of readjustment of boundaries the land was soon sold for building, bringing in the owners a substantial profit.

The first case of a large voluntary adjustment of boundaries is the case of the so-called Kieshaide, a district comprising a total area of 14.2 ha (35 acres), and belonging to a very large number of owners which may be shortly described here as a typical example.

The negotiations with the 54 interested parties were commenced in the year 1897, but led at first to no tangible result, as some owners, owing to want of experience, were over-cautious and refused to proceed. The negotiations were, however, persistently continued and in the year 1899 it became possible to lay out, if not the whole area, at any rate the two southern plots between the Bismarck-Allee and the Moltke-Allee or boulevard. The hesitation of the owners became gradually less and in the following year two further plots between the Moltke-Allee or boulevard and the Kettenhofweg were opened out. But the negotiations with the owners of the last five blocks were very lengthy, as, in spite of the general willingness to treat, the obstinate resistance of two owners had to be overcome, so that it was not till February, 1902, that the readjustment of the whole area was completed.

Although the principles acted upon in this voluntary readjustment correspond as far as their results are concerned with those laid down in the special law, they render, nevertheless, the whole procedure shorter and simpler.

In this case further—as in other similar ones—the whole area required for streets and open spaces was handed over to the authorities free of charge, whereas according to the special law the municipal authorities must compensate the owners, if this area exceeds 30%. In passing it may be remarked here that no serious objections have been raised against a higher percentage and that the latter ranged in the Kieshaide district between 27.1% and 40% of the total area. This percentage was ascertained by calculating for each owner's plot the portion of land required for the new street right up to its center line and the portion of land remaining and available for building purposes. This method was, however, abandoned in succeeding voluntary readjustments and the practice is now—in agreement with the special law—to calculate the total area required for the streets and to divide the whole of the remaining area among the owners in the proportion of the extent of their original property.

With the readjustment of the boundaries the conditions for building on the new plots were settled and the municipal authorities undertook to make the streets—either temporarily or permanently—with water supply pipes and sewers, as soon as the necessary land had been handed over to them. For this work, including 3½% interest from the time of completion, the owners have to reimburse the authorities, when they commence building.

Nearly one-half of the Kieshaide district was built upon at the end of 1903, further buildings are proposed, fine new streets have been made and the whole presents a pleasing picture of systematic modern town development.

In conclusion, it may not be without interest to summarize here once more the advantages of the readjustment of boundaries and the rearrangement of plots of land belonging to various owners for the proper opening out and development of a building estate.

Buildings which are unsuitable in an economic and sanitary sense are prevented and the future occupants do not suffer from ill-conditioned habitations. The property of each owner is improved. Ugly streets are avoided, all new streets are made with proper regard to existing thoroughfares, traffic difficulties which may last years, are ab initio prevented and a continuity in the development of a town brought about. The market in available building land is enlarged and unwholesome speculation reduced. The readjustment of the boundaries with its tendency to a wholesome reform in the private ownership of land merits, therefore, a prominent place among the measures aiming at the solution of the housing problem, which at its root is a land question.

THE ILLINOIS AND MISSISSIPPI CANAL (or Hennepin Canal) which has been under construction for some 17 years by the U. S. Government, as a connection for barge navigation between the Illinois River at Hennepin, Ill., and the Mississippi River at Rock Island, Ill., was opened last week. The first appropriation was made in 1890, and the total appropriations amount to nearly $7,200,000. It is 75 miles long. From the Illinois river it rises 198 ft. in 18 miles to the 11-mile summit level, and descends 93 ft. to the Mississippi in 46 miles. The summit level is supplied with water by a navigable feeder from the Rock River near Sterling, Ill., where a concrete dam has been built. The feeder is 30 miles long, with a fall of 2.3 ft. The main canal is 52 ft. wide at the bottom, with side slopes of 1 on 2 and 7 ft. depth of water. Turnouts 500 to 1,000 ft. long are about four or five miles apart. There are 21 locks for the 196-ft. rise, and 11 for the 93-ft. rise, with one lock (a guard lock) in the feeder. Their chambers are 35 × 170 ft.; some have upper miter gates, and others have upper gates of the Marshall automatic type. Several waterways are crossed by aqueducts and inverted-siphon culverts; there are ten railway drawbridges, 67 highway bridges, and several pontoon bridges for farm crossings. Reinforced-concrete has been largely used in all the structures. Lieut.-Col. Bixby, U. S. Engineers, has jurisdiction over the work; Mr. L. L. Wheeler and Mr. J. C. Long have been Resident Engineers in charge of the western section (and feeder) and eastern section, respectively.

PREVENTION OF THE SHORT-STROKING OF DIRECT-ACTING DUPLEX PUMPING ENGINES.

By A. P. BLACKSTEAD,* M. E.

In comparing respective merits and demerits of direct-acting duplex and crank and fly-wheel pumps the variable and uncertain length of working stroke is always mentioned as a point against the former. Further, that when the piston speed is reduced say 50-60% it becomes impossible to make the pump run full stroke.

As the large clearance accompanying short-stroking materially reduces the efficiency, it is a matter of the first importance to maintain a uniform length of stroke.

In the following, an attempt is made to explain the different ways this may be accomplished on a triple-expansion, duplex pumping engine of the type usually found in water-works pumping stations. These remarks cover compounds as well as triple expansion types, either vertical or horizontal.

When the engine, for any reason, is running short-stroke, the first thing to do is to open wide the dash relief valves on the low pressure cylinders. (These valves are sometimes provided on the intermediate pressure cylinders as well.) If the reduced cushion thereby obtained in the cylinders will not materially improve matters, then the lost motion in the valve gear links should be increased and a later cut-off tried.

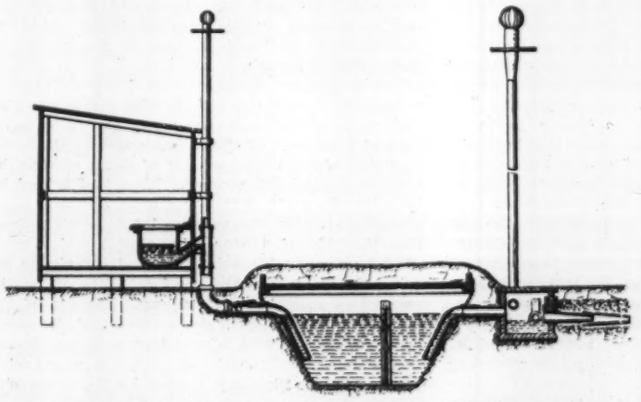


FIG. 1. MODIFIED WATER CLOSET, SEPTIC PIT AND SUBSOIL IRRIGATION SYSTEM FOR ISOLATED BUILDINGS.

These are the only three legitimate methods; however, there are other ways. There is usually a pipe cross-connecting the inlet pipes on the two intermediate pressure and the low pressure cylinders. These connections are usually termed the "cross-exhausts." By opening the valves in these lines one side of the engine will help the other.

The explanation of this action is as follows: While the boiler acts as a receiver, for the high pressure cylinder, of a sufficient volume to keep the pressure constant during a whole length of stroke when no cut-off is used, the intermediate and low pressure cylinders have usually small receiver volumes. Consequently there is a large drop below the initial pressure at the end of the stroke in these cylinders. By using the cross-exhausts the pistons will get a "boost" at the end of the stroke, and although this somewhat decreases the economy, by forming a larger back pressure, it is much preferable to short-stroking.

The practice of opening direct steam connection from boiler to intermediate pressure cylinder (which converts the triple expansion arrangement to a compound), or opening by-passes on the water end should hardly need condemnation. The former is for use in case of fire in order to obtain a higher water pressure, the latter, for draining valve chambers and turning the pump over by water pressure, and for these purposes only.

The foregoing is an attempt to explain the different methods of easily preventing short-stroking. However, as a fact the methods all have their limitations.

In certain cases something of a more radical nature has to be done and the most difficult cases will be found where there is a high water pressure. The water plunger in such cases will not be of sufficient weight so that its momentum can help to finish up the stroke except to a slight extent. As the steam ends for all triple and compound expansion duplex pumps are standard with position and size of dash ports designed to give good results for medium water pressure, they sometimes have to be given a different treatment. The writer has for instance known cases where the main ports in the low pressure cylinders had to be beveled off in order to reduce the cushion.

*Care of Camden Iron Works, Camden, N. J.

A NEW ZEALAND METHOD OF SEWAGE TREATMENT FOR ISOLATED BUILDINGS.*

By JOHN MITCHELL.†

The advances which have been made during recent years in sanitation in the cities of New Zealand are very considerable and gratifying. There is a growing desire to extend some benefits in that direction to the rural districts.

It is well known to householders and members of local bodies that in all cases where there is no proper sewerage and water system the ordinary night soil service or the operation ordinarily performed by individual householders is usually inconvenient, unsatisfactory, and to a degree expensive, besides being more or less a danger to public health.

The more recent adaptations of the septic tank have caused a considerable measure of improvement and given some degree of relief where the principles have been rightly understood and true methods have been properly applied. The cost of installing the ordinary septic tank has, however, greatly restricted its sphere of use, and greatly retarded the progress of reform in that direction.

I have found by experiment that it is possible to provide a special form of closet pan, so contrived that it will, in itself, not only be free from many of the usual drawbacks as a receptacle; but that it may also be combined, in use, with an inexpensive bacterial macerating pit and means for effluent disposal that is simple, inexpensive and efficient.

The closet pan is designed to *suspend* the organic solids in water and to *dilute* the urine, so that there shall be no bad odors arising therefrom. Usually a water closet pan is contrived with the intention of as quickly as possible getting rid of the organic solids by resorting to an effective water flush. In the country and in the cases above recited that is rarely practicable or convenient.

The pan, Fig. 1, is intended to hold and to receive daily about four gallons of water, say an

*Extracted from a forthcoming pamphlet, entitled "Some Thoughts Upon Rural Sanitation and Suggestions for a Betterment."

†Architect, Auckland Education Board, 215 Victoria Arcade, Auckland, New Zealand.

ordinary domestic bucketful. That will generally be found sufficient to satisfactorily suspend the amount of organic matter deposited in the pan for the day. To flush it out twice a day would be still better. The pan is provided with an arm in the back and a vertical discharge pipe so arranged as to make an effective trap or water seal, and at the same time to connect easily at its lower end with the drain leading direct to the bacterial macerating pit. The upper end of the discharge pipe is made to receive the flange of an upcast metal ventilating pipe, where so desired. The metal pipe may be made to unship so as to give access there as an inspection pipe, or a special inspection opening may be formed in the vertical discharge pipe immediately below the flange, if preferred. The vent pipe would be carried up as high as convenient and be surmounted with a wire guard to exclude birds, leaves, and the like.

To avoid the expense attaching to the construction of a concrete or brick septic tank and its gear, I have contrived the already-mentioned bacterial macerating pit, which is a trench formed in the earth itself, ordinarily about 8 × 4 ft. × 4 ft. deep. The side walls and end walls of the pit are made to batter so as to prevent their collapse, and to facilitate the making of their surfaces more or less impervious by a coating of tar, cement, sand, and cowdung, or any other inexpensive dubbing, in contradistinction to brick or concrete walling. In certain cases the earth itself will be found sufficiently retentive, or soon become so when brought into use, as the pores of the earth will sooner or later "sludge up," and thereby prevent the escape of the liquid. The location of the pit must be governed by circumstances, but it would be desirable to keep it not less than 6 ft. away from the outbuilding.

To protect the margins of the pit and to carry its cover, I provide a 9 × 2-in. wooden curbing. On a supporting fillet is laid a protective cover made of 9 × 2-in. tarred planks, having the joints covered with 3 × 1-in. battens nailed to one plank only, to facilitate removal. On that, and between the curbing, is laid a 6-in. layer of fine garden soil.

A cleaning eye is provided at the side of the inlet pipe to permit of the removal of any obstruction that may get into the pipe there. A junction is also provided at that point conveniently to take the drain from the kitchen sink, baths, wash-bins, etc., where such is required for the treatment of house sewage. [Figs. 2 and 3 show a vegetation-covered installation on this system at the home of the author.—Ed.]

To carry the macerated organic matter to the living earth near the surface and to distribute it there, a system of shallow trenches, say 12 to 15 ins. deep and 12 ins. wide, is used. In these is laid a layer of gravel about 3 ins. thick, or scoria, shells, or other hard pebble-like substances. On that are placed field tiles and at the sides and over the top thereof similar material is laid, and finally over that is placed the garden soil (humus) and top sods.

Where the land is of stiff clay, or very retentive, it must be dug up in the neighborhood of the pipes and for some distance away and mixed with sand and humus, so as to let it become "alive" and active. To more effectively distribute the effluent and in certain special land configurations I prefer to use pipes specially contrived for that purpose by Dr. J. P. Frengley, M. D., or those of my own special design as shown by Fig. 4.

FIG. 2. OUTHOUSE AND SEPTIC PIT.

FIG. 3. VEGETATION OVER SUBSOIL DISTRIBUTOR.

FIGS. 2 AND 3. SEWAGE DISPOSAL AT THE HOME OF J. MITCHELL, THE ANCHORAGE, WHANGAREI HEADS, AUCKLAND, NEW ZEALAND.

Where the land configuration demands deviations of the field tiles in several different directions, I provide a small collecting well, and from that I take outlets at a uniform level in any convenient number of directions that may be desired. Obviously, too, any of those outlets from the collecting wells can be easily plugged and the distributing system controlled and made intermittent accordingly, if use, or special conditions, demand such.

Under certain circumstances I have found it necessary to ventilate and thereby aerate the pipe system, so as to carry away any excess of gases formed as a part of the process and at the same time introduce a free supply of fresh air for the invigoration of the aerobes. That is attained by bringing the ends of the field-tile-ducts into communication with the surface by delivering them into the side of a 6 or 9-in. glazed socket pipe, placed on end with a hole formed therein to receive the field tile, and perforated to allow the sewage to spread out therefrom. The top of the 9-in. pipe stands above the surface and the opening is protected with a cast-iron grating. Round about that pipe I usually place a bed of gravel or scoria and the like, say 3 × 3 × 1½ ft., to serve as

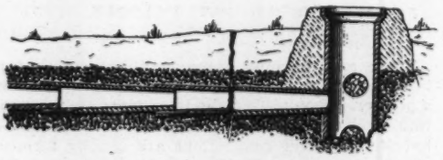


Fig. 4. Special Form of Sewage Distributors for Use in Subsoil Irrigation.

a catch pit for any unusually large discharge of liquid from the bacterial macerating pit and at a time when the humus is already moist, as it would be in the rainy season. It is believed that the introduction of a limited quantity of rain water, from say the roof of a small outbuilding into the collecting well, and thence through distributing pipes, is advantageous. The ventilating pipe is connected with the first collecting well and is nearest to the macerating pit, and is to be carried to some convenient building, fence, or special supporting standards. Thence it is carried up into the air as high as poss[illegible], say 20 to 30 ft., and is surmounted with a [illegible]ecial aspirating head.

Under all ordinary circumstances I b[illegible]e it will be found that one foot lineal of 4-[illegible] field tile, placed as hereinbefore described, wi[illegible]atisfactorily dispose of 1 gal. of liquid f[illegible] the macerating pit daily.

The manner of using those appliances h[illegible]been made so obvious by the extended explana[illegible]n of the appliances, methods and principles a[illegible]ady given, that further reference is hardly n[illegible]ded. Briefly, then, the pan, when to be used, is first charged with clean water, and is to be flushed daily with the morning bedroom slop water, and by an after-bucket, or buckets, of clean water. A corresponding volume of water, excrement, urine and paper is displaced from the pan and carried to the bacterial macerating pit; there a bacterial scum soon forms and prevents the escape of gases to any perceptible or hurtful extent. The organic matters are reduced to a macerated condition and are suspended in the liquid contained in the pit, and are in due course displaced (when the pan is flushed) and carried to and distributed in the living earth by means of the field-tile and gravel trenches. They are there absorbed, changed, converted, purified and utilized by Dame Nature's own methods. She will, too, if coyly persuaded, and earnestly and diligently waited upon by human intelligence and labor, give back an hundred fold, mayhap vegetables, fruit, flowers, shrubs, grass, or, alas, docks! for "whatsoever a man sows that shall he also reap," so beware! Flowers may be conveniently and elegantly grown on the garden soil placed over the wooden cover of the pit.

[The balance of the paper may be summarized as follows: When the slow accumulation of solids in the macerating pit makes cleaning necessary the sludge may be shoveled out and dug into the soil, after which the pit should be filled with clean water. If the tile distributors clog they may be taken up and the surrounding material aerated or else replaced with fresh material; or new tile lines may be laid. Where "snow and ice prevail it would be necessary," Mr. Mitchell says, "to take the usual precaution against such and to make the trenches deeper accordingly." In writing of the desirability of bettering the conditions often found in the vicinity of country dwellings Mr. Mitchell aptly speaks of a "'Queen Anne' front and a 'Mary Anne' back." A considerable portion of the paper is devoted to a discussion of the need of bettering the sanitary conditions of rural schools in New Zealand—a need by no means confined to that country. The author believes that the system of sewage treatment outlined would be just the thing for rural schools. He appends favorable letters from two pub'ic school teachers who have cooperated with Mr. Mitchell in making experiments with the system.—Ed.]

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
ATLANTA: Candler Building
RUDOLF MOSSE, BERLIN AND HAMBURG, GERMANY

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Entered at the New York Post-Office as Second-Class Matter.

As briefly noted in our last week's issue, the Panama Canal Commission is considering a proposal to make the locks for the canal wider than the 100 ft. which was decided upon a year or more ago. The governing motive for this increase of width appears to be a possible future increase in the beam of the largest battleships. At present the British battleship "Dreadnought" has a beam of 83 ft. The two new battleships under construction by the United States, of the "Delaware" class, have 85.3 ft. beam. The naval designers have in contemplation a 25,000-ton battleship with a beam of 88 ft., but such a vessel is not yet authorized. All these vessels, however, could pass the locks now designed. It is therefore only the possibility of still larger war vessels in the remote future that furnishes an argument for increasing the width of the locks.

So far as the merchant marine is concerned, there is no reason to widen the locks. The two new huge Cunarders, the "Lusitania" and "Mauretania," are larger by far than any other vessels afloat, and there is plenty of margin to accommodate them in the lock chambers as now designed. Further than this, these huge vessels are well understood to be in advance of actual commercial demands. As explained in these columns a few weeks ago, their construction was a matter of advertising and success in the sporting field, to break the transatlantic record. As a purely commercial enterprise, they are not expected to be profitable, and would not have been undertaken by the Cunard Co., had not the British Government paid a large part of their cost.

But even if these vessels did represent the coming type for the transatlantic service, there is no reason to believe that any such monstrosities of marine architecture will be needed or will be economical for handling the traffic that will pass through the Panama Canal. So far as the trade with the ports of Asia, Africa, Australia and the west coast of South America is concerned, it must be remembered that the majority of the harbors of these countries are of moderate depth, and that there is little likelihood for a long period of years to come that the harbors will be deepened sufficiently to admit vessels of any size approaching these transatlantic liners. Even if we foresee, after a long term of years, a time when vessels like the "Lusitania" are demanded for the traffic between the chief Asiatic ports and the United States, it must be remembered that the present locks have length, width and depth sufficient to accommodate vessels considerably larger than the "Lusitania."

The question comes, therefore, whether it is worth while to increase the width of the lock chambers above the 100 ft. now proposed, solely to permit a few huge monstrosities in battleships, not yet built nor even planned, to pass through them. So far as we are now informed, such an increase in width, dictated purely by naval considerations, would be extremely unwise. It must be borne in mind that the objection to increasing the width of the locks is not merely the increase in cost, or even the increase in size of the lock gates. These are important, but not so important as the fact that the wider locks will require a longer time to fill and to empty, and will increase to some extent the time required for the passage of every vessel that goes through the canal. Even the present locks, far in excess as they are of any previous construction of this sort, involve very complicated problems in the design. These problems can be successfully solved, we have no doubt whatever. But every further increase in the size of a lock chamber makes a very important difference in working out the design.

It must be remembered that the dimensions at present proposed for the locks are largely in excess of any present requirements for either merchant or naval vessels, and that the locks are far larger than any heretofore planned for the Panama or any other interoceanic canal. We believe the consensus of opinion of the engineers who have given most careful study to the subject would be against any further increase in these dimensions. It is to be hoped, therefore, that the fact that the canal work is now in the hands of military and naval engineers solely, may not lead to any error in changing the lock dimensions already fixed upon.

It has long been the established policy of Engineering News not to publish serial articles. We depart from that policy at this time for the sake of presenting to our readers a paper of especial value to mining engineers and to every one who has to do with wire rope for hoisting purposes.

A few years ago two terrible accidents occurred in deep mine shafts on the Rand, in South Africa. In both of these accidents, steel hoisting ropes broke, by which a cage full of miners was suspended, and the cage fell to the bottom of the shaft from a great height. The outcome of these accidents was the appointment of a government commission, made up of the most prominent engineers connected with the Transvaal mines, to investigate all matters relating to the use of wire ropes for hoisting, and consider what measures could be taken to better safeguard the lives of those engaged in deep mine working.

The report of this commission, just published by the Transvaal Government, is the most important statement respecting safe practice in deep mine hoisting that has appeared for many years. We have found it impossible to condense this report without robbing it of a large part of its value to the working engineer; and notwithstanding its great length we have determined to make it available to our readers by publishing it in full, beginning with the present issue and continuing, week by week, for the four or five issues succeeding.

The question, what is good practise in the use of wire ropes for hoisting purposes, is one on which many engineers have to pass. To condemn wire rope while it is still safe for use, involves a large loss. To continue its use after it has become dangerously weak involves heavy risk to human life and danger of property loss as well. The engineer who has to decide where to draw the line has a heavy responsibility and needs to fortify himself with the recorded experience of his fellow engineers in every possible way. Not only will the study of such records enable him to act with far greater intelligence; but the ability to quote from such official documents as this Transvaal Commission report may be of great service in enabling an engineer to convince the owner or superior officer to whom he reports that the engineer understands his business and is neither wasting money nor trifling with human life.

We give a large amount of space in this issue to the official statement of Mr. Theodore Cooper, Consulting Engineer for the Quebec Bridge, to the Canadian Investigating Commission. Mr. Cooper's high position among American bridge engineers, and the intense interest which the great disaster at Quebec has aroused throughout the length and breadth of the engineering profession has made it worth while to print his testimony in full. It will be closely studied, we are sure, by all our readers who have been following our articles and contributions on this disaster, week by week.

In publishing it, however, it is proper to add a word as to the need that engineers should maintain a judicial attitude in considering the serious question how responsibility should be apportioned for faults in design, construction and erection.

We always prefer to publish both sides, or, if possible, all sides, of a controverted question simultaneously. In the present case, for example, we should have been glad to have printed with Mr. Cooper's statements, the statements also of those who had direct charge of the work of design, and construction for the contractors. This testimony, however, is now being obtained by the Canadian Commission; and, even were it now available, space would compel its postponement to a later issue. But every engineer will recognize the fairness of suspending judgment as he reads Mr. Cooper's statement until the statements of the Phoenix Co. engineers are presented.

We say this in full recognition of the frankness and manliness with which Mr. Cooper has shouldered his burden of responsibility for the Quebec disaster and of the sterling qualities which have won him so high a place in the profession. It is to be remembered, however, that the incidents covered by Mr. Cooper's recital extend back over nearly eight years; that there is much room for variations in memory as to events so remote; that different persons retain different impressions of the same event, especially when they view it from different standpoints; and finally, that extenuating circumstances may be pleaded by those on whom a part of the responsibility may fall.

In saying this we shall not be accused, we trust, of attempting to shield anyone, or desiring to in any way weaken the force of Mr. Cooper's testimony. We are only appealing to the profession to suspend its judgment until all those most concerned have had a hearing.

We understand that the Canadian Commission is nearing the end of its labors. The present week will probably finish its work at Phoenixville and a brief session at New York and possibly another visit to Quebec will complete the taking of testimony.

The production of peat-fuel has long been an alluring field. For a variety of reasons most of the numerous disconnected attempts at the utilization of such deposits have largely resulted in practical failure. There seems at present more hope of economically using this embryonic coal, in certain districts, but the limitations need to be carefully remembered.

Some of the loudly exploited projects for the production of peat-fuel in the past, it may be remembered, were to produce a fuel of properties equal and even superior to coal and at a cost slightly more than nominal. These schemes failed, of course, as the dreams of men who, while perhaps honest and full of confidence in their processes, had not the necessary training or knowledge to judge of proper methods of manufacture and limitations of use. The presence of considerable deposits of peat in localities at a sufficient distance from coal fields seems to offer considerable chance for development by persons able, through training, experience or study, to

cope with the problems involved. There are a very few instances where a fairly good fuel has been produced to sell, with a fair profit to the makers, at roughly $5 per ton, in localities where anthracite coal brought from $7 to $12, and bituminous from $4 to $6 per ton, and in localities where hydro-electric power was not available in small amounts at less than $30 or $40 per HP. year for 24-hour power. In such few cases the local demand has been stated to tax the capacity of the plants. In all similar situations success may be reasonably expected with proper care in the operation of the peat plant. The fuel must naturally be made close to the bogs and cannot economically be shipped to a great radius to compete with coals.

As noted elsewhere in this issue, a group of some 25 men met last week at the Jamestown Exposition to consider the advisability of forming an American peat association. These men had definite interests and experiences in some of the failures and successes of peat working and what is more, they had a realization of the disconnected way in which they had been working and repeating each other's failures. It was also realized that the peat deposits of the country were of such widely varying properties and required such different treatments, that any one person could not, without a considerable organization at his command, adequately follow the development in all parts of America. In other words, the benefits of association were recognized and as a result of the meetings the American Peat Society was launched. It would seem, by the organization of this society, that the safe and sane development of an important fuel resource could be materially advanced, first by the elimination of frauds and incompetents, and secondly by the exchange of experiences and experiments that should result in more practical achievements.

Not in many years have the banks of New York City, where the financial pulse of the nation beats, been under such serious stress as during the last week. The cause may be briefly summarized as lack of confidence leading to a withdrawal of deposits from banks and other financial institutions just at a time when the business community most needed currency. With all the banks impelled to husband their resources and refuse loans, the man or the corporation, great or small, obliged to borrow money has found the greatest difficulty in so doing; even when the security offered has been unexceptionable.

The chief causes of the lack of confidence have been the control of certain banks and trust companies by men who were known to be speculators and whom the public, rightly or wrongly, suspected of using the funds entrusted to their care to further speculative enterprises. Coupled with this has been a distrust of the management of many of our great corporations that has led investors to withhold their funds from them and has sent the price of stocks downward until many good dividend-paying securities are selling at 50 per cent. less than a year ago.

Fortunately, this fall in prices of securities does not represent in most cases a corresponding loss in earning power. General business is still prosperous. Throughout the South and West, farmers are making large profits, money is plentiful, trade and industry are active and are furnishing an outlet for the product of Eastern mills and factories. The railways, too, are carrying all the traffic of which their tracks and equipment are capable. It is reasonable, therefore, to look for a speedy restoration of confidence and revival of industrial activity in the lines where trade is temporarily depressed.

A most unfortunate feature of last week's financial stringency was the placing in receivers' hands of several of the Westinghouse companies, purely on account of the difficulty in obtaining ready money. With these great manufacturing enterprises actively at work on profitable orders, it seems indeed strange that they could not keep their heads above water.

All reports state that the receivership is expected to be of short duration, and that the works will soon be restored to their former managers. It seems proper at this time, however, to call attention to the fact that the financial troubles of these enterprises can be traced, we believe, to the policy of combining the manufacturing business with the business of promotion and development. In the keen competition for business, not only have stocks and bonds of light and power companies been taken in payment for apparatus, but the organization and development of such enterprises has been actively pursued. While there are opportunities for gain in such a business, there are also large opportunities for loss and if we mistake not, the treasuries of several of our large industrial companies are burdened to-day with securities representing a so-called surplus, which are as a matter of fact difficult to market except at a loss and unavailable as collateral for loans.

The improvement of inland waterways is a subject on which national attention is being more and more focused. Following the recent Memphis convention held to agitate for a Lakes-to-the-Gulf deep waterway came a convention at Moline, Ill., on Oct. 23, of the Upper Mississippi River Improvement Association. At Philadelphia on Nov. 19 and 20 a convention is to be held to further the construction of an inland waterway parallel to the coast, extending from Boston Bay to the Carolinas, and possibly still further south. In Washington, on Dec. 4, 5 and 6, a National Rivers and Harbors Congress is to be held at which all the sections demanding waterway improvement will be represented.

Meanwhile the Inland Waterways Commission, appointed by the President a year ago, is expected to submit a report, prior to the assembly of Congress, in which a general plan for systematic waterway development will be laid down; and the recommendations of this Commission, it is scarcely to be doubted, will have greater weight with Congress than appeals from any particular section. As most of our readers are aware, no such thing as a general plan of creating continuous water routes has ever been adopted by the government; but river and harbor appropriations have been made on the theory that every Congressman had a right to have some money spent in his district, notwithstanding the fact that the need for expenditure elsewhere might be many times more urgent.

The completion and formal opening on Oct. 24 of the famous old Hennepin Canal connecting the upper Illinois River with the upper Mississippi River near Rock Island, is a fine example of the plan of carrying on river and harbor work hitherto pursued. The construction of this canal by the Federal Government was due to the granger agitation of the early '80's, and the dimensions of the canal were fixed to enable it to compete with the railways of that day. These dimensions are: Depth, 7 ft.; lock chambers, 170 ft. long, 35 ft. wide. The canal is 104 miles long, and has 32 locks. The total length is about 104 miles and the total cost has been in round numbers 7½ million dollars, or about $72,000 per mile.

As stated above, the canal was projected and surveyed in the '80's, but the first appropriation for construction was not made till 1890, and money has been doled out in driblets for seventeen years since.

If the canal was worth building at all, it was worth building in a continuous business-like fashion from start to finish, and two or three seasons should have sufficed for the entire work. But to string out the work over a full quarter century from the time it was projected and its dimensions fixed, involved first an enormous waste in invested capital lying idle while work was in progress, and second, loss through the fact that with the lapse of time the plan of the work became obsolete and unsuited to changed conditions.

Boston was the pioneer among American cities in providing subways for the use of street cars in its congested district. The Boston subway became a necessity in the very early stages of electric railway development because of the narrow streets and congested area of the city. To-day a great number of cities are facing conditions similar to those in Boston fifteen years ago. Subways for street car traffic are likely to be adopted in the near future, not only in the larger cities, like New York and Philadelphia, but in cities of the second class. In Los Angeles, for example, one of the electric railway companies operating cars to suburban points is building a long tunnel by which it is claimed its cars will save some 15 minutes' time on each trip.

It will certainly interest those of our readers who have had some experience in building concrete structures to see how their poor little achievements pale into insignificance in comparison with Mr. Thos. A. Edison's promised feats in concrete house building. When the Electrochemical Society visited his laboratory last week, he showed a model of his new scheme for house construction and expatiated on it as follows, according to the New York "World":

By means of a system of patent molds it is possible for any contractor to build for $1,000 a house of solid cement 25 ft. wide and 45 ft. deep, three stories high and capable of comfortably housing three families.

The material for the house is to be composed almost wholly of a new composition of mine consisting of 1 part of cement, 3 parts of sand and 5 parts of quarter-inch crushed stone.

By pouring the cement into the molds, beginning, of course, at the top until the whole mixture overflows, it will be possible to build the house in twelve hours, and in six days more it will have settled and hardened so as to be absolutely indestructible.

The molding forms are of cast iron, nickel-plated inside, and for $1,000 the entire house can be built. This to include heating pipes, staircases of cement, floors and mantels of cement and a cement roof that won't leak. Plumbing and even bath tubs will be of cement.

The durability of the house is unquestionable. It will last forever. Even children may go around with axes and chop as long as they like without doing any material harm.

Therefore there will be no necessity for repairs. Even the window sashes will be of cement. It will cost a contractor $30,000 to get the molds with which to build the house, but then he will be able to build over 30,000 houses with the one set of molds.

The molds can be taken down in a few hours after the house has been finished, and they may be carted to any part of the world in less space than is required for shipping an ordinary derrick.

Of course, I have patented the house, but I shall give any one the rights for nothing provided he uses the right kind of concrete, reinforces it properly with twisted iron rods, and makes an artistic product.

Engineers who have personally wrestled with the task of putting concrete into molds, particularly molds of small width and particularly also when the molds contained reinforcing rods, can easily picture a three-story mold with the wet concrete flowing in at the top like molasses into a jug, and can also picture the resulting structure—if any structure really results. But lest they be unduly discouraged because things which they find so difficult are so easy for the "Wizard of Menlo Park," as the newspaper reporters call him, we reprint also another paragraph from Mr. Edison's quoted remarks, which may be taken to indicate that he also finds that the ideal concrete and the actual concrete are two different things:

I've been working on this two years. That's the way it is with everything I do. The idea comes easy enough—doesn't take 1% of my time. But the details mean plug, plug, plug. And the worst part of it is, when you've done anything it's never perfect, and never will be.

CITY PLANNING AND REPLANNING.

Of the thousands of cities on the globe only a few can justly claim to having been built in accordance with a well-conceived plan. This is not surprising when it is considered that instead of having sprung, Minerva-like, into full and glorious being most cities have, Topsy-like, "just growed." It is surprising, though, that in a century supposed to be pre-eminently utilitarian, but which, nevertheless, seeks after the beautiful in no small degree, a continuation of haphazard municipal growth is so generally tolerated, and that so little well-directed attention is given to

those features of municipal planning that contribute to the convenience and to the esthetic pleasure of those who use the public streets, open spaces and buildings of our cities. Among several recent indications of an awakening to the need of what for a better term has come to be called "city improvements," we may note the appearance of a considerable number of reports on that subject. These are of diverse origin and nature but are similar in that they deal with the general street plan of each of the several cities involved; its open spaces, both paved and green; its parkways, either actual or needed; its water fronts, in existence or possible; and its municipal buildings, particularly as regards their grouping in main and subordinate civic centers, for both the convenience of their users and the dignity of the city as a whole. Perhaps the most marked characteristic of all these reports is the consideration they give to municipal esthetics, as exhibited by well-designed, well-constructed and well-kept streets, avenues and parkways; the utilization, improvement, or creation of beautiful landscape features; and the securing of good municipal architecture (and perhaps sculpture), frequently through the creation of municipal art commissions to approve or disapprove all proposed buildings, bridges, monuments or statues to be erected at municipal expense or, however paid for, to be located in parks or other public places.

Taking up, briefly, some of the improvements most commonly suggested in these reports, changes in street plan may first be noted. The most generally needed of these changes is the widening of old and the opening of new main lines of travel, including, oftentimes, the creation of new diagonal streets to obviate the zigzag course made necessary in passing between, say, northeast and southeast points in cities laid out on the checkerboard plan.

Besides facilitating traffic, a street cutting or widening may be desirable to open up a view of an imposing building, as was urged in the recent report of the Capitol Approaches Commission, in the case of St. Paul, Minn. This is a highly commendable motive, which may involve the widening or creation of more than one street and, in addition, the tearing down of buildings and creation of parks or other open spaces on one or more sides of an important public building. The best American example of the value of wide avenues leading to an imposing structure is afforded by the various diagonal and other streets leading to the Capitol Building at Washington, D. C. An example of the blocking of open spaces so as to hide a notable piece of architecture behind a mediocre or ugly one is afforded by the location of the New York Post-Office, in the southern triangular extremity of City Hall Park, thus shutting off the impressive view of that building from points well down Broadway.

Street plans in general as we now see them on maps are largely the result of accident, except where the checkerboard or rectangular plan was deliberately chosen, as by William Penn, for Philadelphia, by a commission for New York City, and by various means in the case of many of our newer cities, particularly in the West. Where diagonal streets are found they are frequently old postroads or turnpikes, converging from various directions. In a few instances, a more or less distinct radial street plan may be seen, and in the case of Karlsruhe, Germany, radial streets are combined with segments of circles. The radial streets, if continued to that point, would all center in a palace or castle, in front of which is a park. The local story is that the city was laid out on the radial plan in order that some prince of the olden times might command a view, from his castle, of each approaching street.

Other instances of street circular or approaching thereto in plan may be seen in Europe, where old city walls have given way to boulevards. Such there are, to name only one case, in Paris, a city pre-eminent for its excellent main street plan, which partakes largely of the diagonal, and was created at great expense a few decades since.

The rectangular street plan, if provided with diagonals, has some decided and quite obvious advantages, especially from the real-estate viewpoint. It is at its best in flat or relatively flat country and at its worst in hilly sections, particularly if these are bounded by irregular water fronts. Seattle, Wash., is a notable example of misfit rectangular city planning. Here one of the most magnificent natural sites in the world, consisting of hills bordering on a noble bay and sheltering several beautiful lakes, with irregular shores, suggested, at least for the residential portions, a street plan based as far as possible on contour lines. Instead, with minor exceptions, due to the taste and sagacity of real estate developers, the streets run up hill and down dale with ugly uniformity, sometimes cutting great gashes in the ground and still having steep grades. Seattle might profit by a study of the street plan of Bournemouth, a seaside and health resort in the south of England, whose streets curve to suit an extremely varied topography and give rise to many pleasing effects. Doubtless Bournemouth goes to the other extreme, but that matters less in the case of a health and pleasure resort. There is a happy mean and for that each city should seek.

Much, but by no means all, of the confusion and ugliness of American streets and street plans is due to the lack of municipal control of laying out new streets, particularly in extensions of the built-up areas. In these "additions," as they are called in some parts of the West, the streets are often laid out with utter disregard of the general city plan, and seemingly regardless of any consideration whatever, including even the economic interests of the landowners. Elsewhere in this issue, it may be noted in passing, is a brief description of the successful efforts to improve street layouts and the boundaries of abutting lots in unbuilt areas in Frankfort-on-the-Main, Germany.

Of the many neglected opportunities for municipal improvement in America none are more marked and few are more to be regretted than those pertaining to water fronts and water parks. Compared with European cities, we have done scarcely a thing in this country to develop breathing and beauty spots along rivers, lakes and ocean and in the rivers and lakes themselves. Boston and vicinity has most to show in this respect, and will have still more when the Charles River Dam and Basin are completed.

Comparatively few American cities have municipal buildings worthy of their wealth and of their enterprise in other directions. This is more true as regards city and town halls than of schools and libraries. Where public buildings in themselves creditable exist, their settings, as regards open spaces and surrounding structures, are generally far from being dignified and otherwise in keeping with the buildings themselves. In addition, such municipal buildings as have been provided, be they suited to their purpose and pleasing to the eye or not, are as a rule scattered about promiscuously, instead of being grouped to form convenient, dignified civic centers, as in many European cities. Extensive and carefully wrought plans for the effective and convenient grouping of municipal and other public buildings have been worked out for the city of Cleveland and have been suggested for a number of other cities.

Only a few of the points suggested by our topic, City Planning and Replanning, have been discussed, but perhaps enough has been said to show the importance and complexity of the subject and the need for giving it careful study in every city and town. How can such studies best be carried out? Perhaps there is little use of attempting to answer the question, since there is no one best way and since the main thing is to have the much-needed investigations made. The most efficient plan, however, where local conditions are favorable, is to have the study of needed improvements made by or in behalf of the municipal authorities who have the power to vote the money and otherwise provide the means for carrying suggested plans into effect. In New York City, a City Improvement Commission was created by the Board of Aldermen. It included borough presidents and prominent citizens in its membership and was assisted by an advisory board consisting of heads of important city engineering departments. In Boston, the Boston Society of Architects appointed a Committee on Municipal Improvements, which investigated some of many needs of that city and reported on them at length. At present there is at work in Boston, from a somewhat different viewpoint, a special Finance Commission, created by the City Council, at the suggestion of the Mayor. St. Louis has recently had the benefit of reports (presented in one volume) by a half dozen committees, composed of representative citizens appointed by the executive board of the Civic League of St. Louis. The Municipal League of Greenville, S. C., has recently published a report prepared for it by a Boston firm of landscape architects.* At Toronto, Ont., The Guild of Civic Art has been working for some two years on city improvements, including (to quote a letter to this journal from Mr. W. Ford Howland, Honorary Secretary) "a well-connected system of parks and parkways, and also two wide diagonal thoroughfares running through the center of the city."

It matters little how studies for city improvements be made, provided only the desired results be achieved. As we have intimated, the best of plans cannot be materialized unless it is approved by the municipal authorities charged with appropriating and spending money from the municipal treasury. But even though a project for city improvement does not originate with the city authorities and does not have their full support a well-wrought scheme is almost sure to be advantageous. Such a plan will open the eyes of many individuals, and possibly of a large and influential portion of the public, to the possibilities of making the city more convenient and more beautiful. In addition, it sets up an ideal, which may, perchance, never quite be lost sight of, and some features of which are almost sure to be adopted as opportunities arise. Even small improvements at intervals will effect notable changes after a number of years, and every small improvement is an object lesson and an incentive to other and larger ones. Now and then a community will rise nobly to the opportunity presented by a plan for municipal improvements and add itself to the slowly growing list of well planned, beautiful cities.

LETTERS TO THE EDITOR.

Disjointing Cast-Iron Water Mains With a Gasoline Torch.

Sir: I noticed in your issue of Oct. 10, 1907, an article on "Disjointing Cast-Iron Water Mains." A few years ago I was required to take up some 4 and 6-in. cast-iron water pipes and replace them with 10 and 12-in. I used a gasoline torch with a large burner and found that I made very good headway with one torch and did not heat the ditch up much as I used a hood for the joints, concentrating the heat on the joint. I melted only every other joint and then hauled the pipe to some place where large fires could be built to melt the other joints. This worked very satisfactory on these sizes and I would like to know if it has ever been used on larger sizes. The lead saved almost paid for the expense of melting the joints.

Respectfully,
A. M. Martin,
Supt. Bisbee-Naco Water Co.

Bisbee, Ariz., Oct. 16, 1907.

Typhoid Fever at State Insane Hospital, Trenton N. J.; Permanganate of Potassium Unsuitable for Detecting Sewer Leaks.

Sir: In the Engineering News of October 3, 1907, I read with interest an article on the typhoid outbreak at the State Hospital, Trenton, N. J., and observed therein that "two 4-oz. doses of potassium permanganate at three-hour intervals failed to establish conclusively that the sewage to which it was applied reached the spring, but bacterial analysis of the spring-water indicated sewage contamination, as did also dosing the sewage with red aniline dye solution." Such a negative result was to have been expected, because the violet color produced by potassium permanganate is almost instantly dis-

*The various reports named in this article have been noted in recent issues of our Engineering Literature Supplement.

charged by organic material, such as would be found in sewage. It is therefore an eminently unfit substance to employ for such a test.

Yours very truly,

W. P. Mason.

Rensselaer Polytechnic Institute, Troy, N. Y., Oct. 19, 1907.

Disintegration of Concrete Exposed to Sea-Water Between High and Low Tides.

Sir: A short time ago an article appeared in your paper on the disintegration of concrete between high and low tide-marks in sea-water. Concrete has been used in eight different places in clear sea-water along the line of this railway, and disintegration of the outer skin has taken place in every case, from ⅛-in. to 6 ins. in depth. It has been used principally to encase stone piers and abutments, in thicknesses of 1 to 2 ft. At one bridge the casing has been twice renewed near low water and at another three times renewed in 6 to 8 years. The concrete mixture is generally 1:2:4, using best Portland cement.

In the inland sea at Baddeok, C. B., where the tide rises only 6 ins., a concrete culvert 4 years old is undercut 3 ft. at two corners for a height of 18 ins., although the concrete is of first-class quality. In the Halifax dry dock, the broken face of the concrete has been chipped off and a band of vitrified brick several feet wide now appears around the dock.

When I first mentioned the matter of the surface disintegration of concrete in your paper two years ago, a Montreal correspondent called it in question and was quite sure that the concrete was not properly mixed, etc. I feel quite safe in saying that the best concrete between high and low tide-marks in clear sea-water, will not retain a presentable face in this climate for any great length of time and in a few years will require to be repaired or renewed.

Our Inspector of Works, Mr. H. J. McGrath, has made the discovery that this assertion does not apply where sea-water carries sediment, such as in some parts of the Bay of Fundy; but that the sediment penetrates into the pores of the concrete and also forms a slimy coating or skin on the surface, which protects is from disintegration by making the concrete waterproof and consequently frostproof.

The engineers of the New York, New Haven and Hartford R. R. are acting wisely in using stone piers and abutments in clear sea-water in preference to concrete, at least between high and low tide-marks.

Waterproofing compounds, such as "Medusa" or "Clay" mixed dry with the cement, or an external liquid coating such as "Impervo" may, perhaps, prove beneficial; and both "Medusa" and "Impervo" are now being experimented with on this railway.

Yours truly,

Wm. B. Mackenzie,

Chief Engineer, Intercolonial Railway of Canada.

Moncton, N. B., Oct. 11, 1907.

[In the editorial referred to by Mr. Mackenzie (Eng. News, July 18, 1907) we called attention to the necessity for reports from engineers experienced in the use of concrete along tide waters, such reports to be collated and summarized for the benefit of the profession. To date we have not received information along this line of sufficient amount or importance to warrant publication. However, at the meeting last week of the Association of Railway Superintendents of Bridges and Buildings at Milwaukee, a few replies were presented to inquiries of a similar nature. We summarize these on p. 461 of the present issue. They are very few in number, but such letters as were received seem to show a very certain and rapid deterioration of the intertidal space on concrete masonry.

Since the stability of concrete masonry in sea water is largely dependent on its impermeability, the clay and electrolyte mixtures noted by Mr. R. H. Gaines in his paper (Eng. News, Sept. 12, 1907) should be an additional protection for such structures. If the surface of the concrete can by these methods, be made so close grained as to prevent the intrusion of the destructive salts of sea water, a large step forward will have been taken toward a permanent structure. The necessity of more data on the disintegration of concrete by sea-water was discussed at the recent meeting of the National Advisory Board of Fuels and Structural Materials at the Jamestown Exposition. The advisability of having the Technologic Branch of the United States Geological Survey undertake experimental work along this line was shown and some such operations may be expected in the future.—Ed.]

More Concerning Municipal Ownership.

Sir: Assuming that a discussion of the paper on "Municipal Ownership of Public Utilities," by John W. Hill, M. Am. Soc. C. E., published in your issue of Oct. 10, 1907, is in order, the following is submitted:

The writer believes that the appalling amount of corruption and graft, which for the last few years has been exposed in this country, and fresh revelations of which are now coming to light every day, is caused by corporate ownership of public utilities more than by any other one cause. Consider the wholesale purchase of public officials in San Francisco by public utility corporations, the colossal fortunes that have been piled up by crooked work in railroad operations, the great sums involved in the remarkable transactions of the Quiggs and the Dolans in the New York Street Railway affairs. When we remember that the recent board which investigated the matter of municipal ownership for the public edification actually had part of its expenses paid by the opponents of such ownership, one can but feel the necessity of probing to the bottom the arguments against municipalities owning their public utilities, together with the personalities and histories of those who produce such arguments.

Mr. Hill's principal claim for having public utilities run by corporations instead of by the municipality is that it is more economical "from a business point of view." He does not clearly state to whom the economy finally comes home. He shows with some clearness that the agents of a corporation generally drive better bargains than the agents of the municipalities. This can be granted and yet it need not follow that the people get their gas or their water or their street car service any cheaper than they would even under the gross mismanagement of the political bosses of our municipalities.

For example, the company that furnishes Philadelphia with gas is skillfully run on business principles. Its affairs are managed scientifically and economically, and it gives excellent service, but the consumer pays an enormous price for the gas he gets. The faithful employees who give good service to the company, if paid the same salaries, promoted with the same fairness, and given the same tenure of office by a municipality would serve that municipality just as faithfully as they serve the company. The majority of them probably could not identify their employer. Then why should not the municipality get the benefit of the economy?

It is doubtless true that the service, when the municipality ran the gas works, was very bad, and gas cost as much as it does now, but that was under a boss-ridden regime, and, in addition to the evils inherent in that fact, the conditions were doubtless intentionally made as bad as they could be to induce the people to turn the works over to a corporation.

It seems reasonable to believe that even under ordinarily bad political management the people would get just as good gas just as cheaply as they do under the more businesslike management of the company's own affairs.

But the other phase of the matter is the more important Companies controlling public utilities must be regulated. They can not be permitted to give any kind of service that they desire at any price they choose to fix. The right to do this regulation must be delegated to a small number of persons. The sums involved are so large that the public utility corporations can always afford to make these few men comfortable, or wealthy, in return for favors in the matter of regulation and no one doubts that they often do it. It is to the corporation's interest to see that purchasable men are placed in these responsible positions. This turns the corporations into a powerful force for corrupt government.

Do not public utility corporations the country over put up vast amounts of money and give all kinds of assistance to keep the local political bosses and the gangs in power? Are not the evils that flow from this vastly worse than those that might result from the appointment of incompetents for political reason whose bad management merely makes work more expensive?

Do not the evils of corporate ownership and of municipal ownership both lead up to the same fountain head of iniquity, the political boss and the corruption of elections? Are not the arguments advanced by Mr. Hill really arguments to show that municipal ownership with concentrated and direct responsibility, with the rigid enforcement of civil service rules, is the best remedy for both types of municipal evils?

That municipalities will always be content to let their business be run by a pack of shameless rascals is not believable. Some day they will awaken to a common sense view of the business of supplying themselves with water, gas, etc., and put it on the same business basis that every other incorporated organization does now. That day will not be hastened by tightening the grip of corrupt corporations on the public utilities.

Very truly yours,

Cassius E. Gillette.

1030 Land Title Building, Philadelphia, Pa., Oct. 18, 1907.

Reports from the Engineers on the Madeira Mamore River Ry. in Brazil.

Sir: Having just returned from engineering work on the Madeira-Mamoré Ry. in Brazil, for a short visit in the States, I wish to say in regard to the article appearing in the last issue of the Engineering News that my opinion of the way in which Mr. Miller, the Chief Engineer, handled the work down there is quite different from that of the writer of that article. When an engineer accepts a position in these tropical countries, he should not expect to find first-class hotel accommodation right away, but should allow a little time for the building of these accommodations. Under the circumstances, all that could be done for the comfort of the men was attended to.

Large quantities of all kinds of food supplies were brought from the States; besides, there is at Santo Antonio the warehouse of Suarez & Cia., containing almost everything in the way of canned foods. Should a shortage occur at any time, everything in the outfitting and supply line can be ordered and received from Manaos in a short time.

On the way up to Santo Antonio with the first staff of engineers, Mr. Miller bought a dozen head of cattle to supply fresh meat, and there never was a shortage of any kind in the supplies; on the contrary the dining table was remarkably well supplied, and everyone seemed satisfied with the conditions.

On the first day of arrival, filters brought from the States were installed to supply wholesome drinking water, and up to the time of my departure the doctor had not reported any sickness due to bad water. One of the first things accomplished was the establishment of a temporary hospital in a "barraca" (native house) leased from a resident, and a large new tent, both well equipped with cots and blankets. A hospital has now been established about four miles from the regular quarters, where the doctor can devote all the time necessary to the welfare of the sick, who are well supplied with good food, such as turkeys, chickens, soup, eggs, etc.

The only deaths were among the natives, who could not be made to take medicine and refused to follow the doctor's orders in regard to diet, etc.

The work is progressing well, the location of the first ten kilometers having been approved by the Government's fiscal engineer some time ago.

While the writer thinks the climate is unhealthy and the conditions rough, yet the impressions given by the recent article are greatly exaggerated. Yours truly,

Torsten Carlander.

American Society of Swedish Engineers,
Brooklyn, N. Y., Oct. 28, 1907.

Notes and Queries.

Mr. H. M. Wilson, Washington, D. C., writes:

I wish to make correction of a statement in your issue of Oct. 17, p. 405, middle of first column, in which I say that there is about to be put in operation a new testing machine of capacity of 1,200,000 lbs. This should be corrected by saying that "plans are being prepared, and it is expected that contracts may soon be let for a testing machine of this capacity. The largest machine now in operation at the Structural Materials testing plant at St. Louis is one of 600,000 lbs."

ASPHALT MINING IN SYRIA is described by W. A. T. Allen in the "Iron and Coal Trades Review." The mines are near Kferie, a village 30 miles northeast of the port of Latakia. The mines are somewhat exceptional geologically, as they form a part of a hill 900 ft. in height, known as the Yebel Kferie. At a height of 216 ft. layers of asphalt extend over a length of 4,500 ft. and a breadth of 4,200 ft. The estimated content of the seams is from 150,000,000 to 200,000,000 tons. There is an undertaking on foot to work the mines, funds being said to have been provided by Egyptian capitalists. The influence of such a large deposit of asphaltum will undoubtedly be felt in the asphalt paving industry in Europe, if the extent of the deposits is as great as it is estimated to be.

THE POTRERO TUNNEL on the Western Pacific Ry. at San Francisco is being rushed night and day, according to the San Francisco press. The total length of the tunnel will be 1,625 ft., or, with its open-cut approaches, 2,800 ft. The original plan was to have a double-track tunnel, but the urgent demand for the hurried completion of the line in time for cooperative freight handling in connection with the finished Oakland terminal, and the opening of the new road next year, made the builders decide upon a timber-lined, single-track tunnel, 17 ft. in the clear. As the traffic increases, a parallel tunnel will be driven, with but a thin wall separating it from the present tunnel. This tunnel will be concrete lined, and eventually the present one will also be concrete lined. So far only the upper bench at each end of the tunnel has been excavated, this being in 265 ft. at the south end.

THEODORE COOPER ON THE QUEBEC BRIDGE AND ITS FAILURE.

Ever since the fall of the Quebec Bridge on Aug. 29 there has been great interest among engineers as to the opinions and comments of Theodore Cooper, the Nestor of American bridge designers, who was Consulting Engineer for the ill-fated structure. "What does Cooper say about it?" was almost the first remark in engineering circles when news came that the bridge had fallen. Mr. Cooper, however, has steadfastly declined to make any statement, or reply to any criticisms or questions as to the design or the construction of the bridge. He expressed his purpose to place all his correspondence, records and calculations before the official investigating body, the Commission of Inquiry delegated by the Canadian government to report upon the accident, and to make before this commission as full a statement of his connection with the work as they might desire.

As many of our readers know, Mr. Cooper, who is now 70 years of age, has been in poor health for several years, and for months past he has been unable to be regularly at his office. The Canadian Commission, therefore, which spent the week from Oct. 14 to Oct. 19 in New York City, visited Mr. Cooper at his residence, conferred with him concerning the matter on several successive days, as his strength permitted, and finally formulated a series of questions covering the matters pertinent to the inquiry. Replies to these questions were dictated by Mr. Cooper at his leisure, and this testimony, after its reduction to writing, was fully reviewed and revised by the Commission and Mr. Cooper in a further conference, until it represented, as completely as the Commission could determine, the full testimony which Mr. Cooper was able to give. It is to be understood that the Commission further was given free access to all the records, correspondence and calculations in his possession; this material in fact forms a very large part of the Consulting Engineer's testimony.

We reprint below Mr. Cooper's statement in full and have commented upon it in our editorial columns.

Q. What were your first relations with the Quebec Bridge Company or with any of its officials and at what date?

A. About Feb. 25, 1899, I received a communication from the Quebec Bridge Co. asking if I was at liberty to take up the examination of their competitive plans. I replied in the affirmative. The next occurrence, as far as my memory goes, was upon the 23d of March, when Mr. Parent, Mr. Hoare and Mr. Barthe, the secretary, came to New York and had a personal interview with me. They gave me a brief account of what the plans were, I having had no previous knowledge of the same, and asked me upon what terms I would undertake the examination and how much time it would probably require. I stated, with the slight knowledge I had of what they were describing, and assuming that they wished a relative report rather than a detailed critical report on all the numerous plans, that I thought it would require about three months' time, and I stated my fee for performing that service. They then asked me under what terms I would act as consulting engineer when the work was under construction. I stated my fee. They then asked if the inspection work was included in my services. I distinctly stated it was not. They then asked me to give them an estimate of what the probable cost of inspection would be. I told them that with the slight knowledge I had of the subject my estimate would be very much in the line of a guess, but I assumed from the magnitude of the work and from what I supposed it would be that it would probably cost from $20,000 to $25,000 for the shop inspection. I do not think they accepted any of my offers at that time, but Mr. Parent left me under the impression that the plans would be sent to me. My offer as consulting engineer was not acted upon.

Q. Previous to your engagement to report upon the competitive plans had you been consulted in any way about the project and had you seen the plan and specifications prepared by the Quebec Bridge Co.?

A. No, I had no knowledge in regard to the project except what was in the technical papers stating what they proposed. I had no definite knowledge except the general knowledge that they were preparing to build a bridge at Quebec.

Q. Were the outlines of the preliminary plan prepared by the Quebec Bridge Co. generally followed in the final design?

A. That question I do not thoroughly understand, but I suppose it has reference to the legal requirements which, I think, were embodied in the tracing showing the profile of the river, the distances and the legal requirement of 1,200 ft. at a certain elevation above the water. That is the only preliminary plan that I know of.

Q. By whom were the details and outlines of this preliminary plan suggested?

A. I do not know.

Q. Did you consider that any change in the general type or outline of the structure was desirable and were any studies made to this end?

A. Certainly not at that time because I had no knowledge of any type or other outline than before mentioned.

Q. At the present date and with the advantage of the several years of additional experience would you confirm your original recommendation both as to the type of the structure and as to the merits of the design submitted?

A. Yes, if under the same limitations that existed at that time as to the amount of funds apparently estimated for the construction. That is an important point because the structure was apparently limited to the amount of funds they had in sight as far as it was impressed on me. The impression was given me that this work was to be constructed by a private corporation, that the amount of money that they expected to have was a limited amount and the question to be decided was the possibility of building the best bridge within the financial strength of the company. The question of the best bridge was not brought up at all. So that, to answer that question a little more fully, it must be limited by that statement, but with my present knowledge I could make further recommendations.

Q. It is not an unknown practice, is it, for a bridge building company to secure the promise of a contract from the promoters at a very early date and in advance of the calling for competitive tenders?

A. It is a general belief that that is not an unknown practice.

Q. Have you any reason to think that any such understanding existed between the officials of the Quebec Bridge Co. and the Phoenix Bridge Co. previous to the final award of the contract?

A. Not to my knowledge. I was left absolutely unhampered in any manner in my report as to which I should consider the best plan and the best bridge. In no manner was there anything indicated to me that one plan should be preferred over any other or any one bid over any other.

Q. On what date did you accept appointment as consulting engineer of the Quebec Bridge Co.?

A. I received a letter appointing me consulting engineer to the Quebec Bridge Co. on May 6, 1900.

Q. What extent of professional responsibility was given to you in connection with this work by the Department of Railways and Canals, and how and when was this responsibility given?

A. In a supplementary report with even date of my report upon competitive plans, June 23, 1899, I stated in a general way that my examination of the competitive plans was based entirely upon the specification and data furnished me by the Quebec Bridge Co., that I thought, before the construction of the work should be undertaken, careful study should be made to see if a better bridge could not be had and whether a change of span was not desirable. On May 10, 1903, Mr. Parent informed me verbally—I think it was—that the financial affairs were in such shape that the work could now be done. I then took up again with the Phoenix Bridge Co. and with the chief engineer the necessary modification of the loads and stresses to suit a bridge of this magnitude. After considerable discussion between Mr. Szlapka, the designing engineer of the Phoenix Bridge Co., myself and Mr. Hoare, it was found that nothing could be done in the way of changing the original specification except with the authority of the Deputy Minister of the Department of Railways and Canals. After considerable correspondence (which is on file) and discussion and a personal visit by myself to Ottawa, I received, on Aug. 23, a copy of an Order-in-Council, dated Aug. 15, certified by the clerk of the Privy Council, giving me, in a general statement, the authority to make modifications from time to time in the specifications and the proposed loadings subject to certain provisos and "provided the efficiency of the structure be fully maintained up to that originally defined in the original specifications attached to the company's contract."

Q. Did you at any date ask to be relieved of your duties and for what reasons? If you made such a request at whose instance was it withdrawn?

A. I cannot give dates, but fully three years ago, I think—certainly over two years ago, before the work of erection had commenced at Quebec—Mr. Parent, in my office, asked me when I was going to Quebec next. I answered: "Mr. Parent, I never expect to be able to go to Quebec again; I am under the ban of my physician and I feel that I ought to be relieved of the responsibility which is upon me as it is impossible for me to give it that attention that I conscientiously feel I should do." I do not, of course, know whether Mr. Parent looked upon that as an official statement, but he protested, and said: "Mr. Cooper, we never intend to let you go until the bridge is done; we have confidence in you and we want your services continued."

About the same time I told Mr. Deans, the chief engineer of the Phoenix Bridge Co., that I thought I should withdraw, that while I appreciated the complications that it would involve and the difficulty of their mutually selecting somebody who would be satisfactory, I would gladly withdraw from any further responsibility. He likewise protested and said they could not submit to that, that they did not know of any one upon whom they could all mutually agree, that they felt the same confidence in and to whom they would be willing to submit an important contract like the one under execution. Realizing this difficulty, and feeling also a pride and a desire to see this great work carried through successfully, I took no further action.

Q. Was your advice asked in connection with the framing of the contract for the construction of the bridge, and if so, upon what points?

A. I do not recollect in any manner having been consulted on the framing of the contract.

Q. Are you conversant with this contract?

A. I have no knowledge whatsoever in regard to this contract except what I have gathered casually and inferentially from time to time.

Q. Did you consider that the Order-in-Council of Aug. 15, 1903, gave you as consulting engineer for the Quebec Bridge Co. full and absolute authority to amend the specifications and to order such alterations in the construction plans as seemed best in your judgment?

A. Yes, under the restriction that the efficiency of the structure should not be in any way reduced from that originally proposed and subject to the provisos previously referred to.

Q. Had your decisions to be referred for confirmation to any officials of the Quebec Bridge Co. or of the Dominion of Canada?

A. I think every change of any importance, certainly all those in the specifications, were referred to the chief engineer, Mr. Hoare, and supposedly through him to the Department.

Q. Please state what alterations were made on your advice and on your authority to the original specifications attached to the contract? Were these alterations accepted by the Phoenix Bridge Co. without discussion and were they observed by it throughout the work?

A. As an experienced engineer of many years' standing I recognized that the original specification of the Quebec Bridge Co. was what I would call a "scissored" one, that it was not drawn upon any theory by any person having the importance of this bridge structure in his mind. Although a specification for a Canadian bridge, there was no recognition of the snow weight that must at times come upon this structure. The requirements for the wind strain were those practically imposed upon the Forth Bridge against the protest of the chief engineers of that bridge, Messrs. Baker and Fowler. The train load and train requirements were not as great as I thought they should be in the present state of transportation. I saw that a large amount of the material in this bridge was going to be devoted to giving it horizontal strength against an imaginary and an impossible wind, material that could be much more favorably placed to give the bridge vertical strength under higher train loading.

I therefore corrected the specifications to provide for a less wind strain than that originally required, with a greater vertical loading than that at first required. Being impressed with the necessity of restraining the weight of the structure under these new loadings and changes of loads so that it would not exceed the original estimated weight contained in the contract, I made modifications in the unit strains to be employed upon the various members with the view of keeping the final weight within the limitations and yet obtain more harmony in the relative strength of the different parts of the structure.

Previous to taking up the consideration of the new loadings, the 210-ft. spans making the approaches on each side had been constructed. On examining the plans, when submitted to me, I found that the floor system was excessively heavy. I immediately wrote to Mr. Hoare, the chief engineer of the Quebec Bridge Co., that I found the floor system on these 210-ft. spans unnecessarily heavy, that they exceeded by 18 to 20% the best requirements of the Pennsylvania Railroad and all first-class railroads in the United States; that I understood that directions had been given to build these approach spans according to the official specifications of the Department of Railways and Canals of Canada. I wrote Mr. Hoare as follows:

"While it is a matter of not much importance for these particular spans, if this is to be taken as a precedent for the main spans, it will add considerably to the weight."

I afterwards explained that for every extra pound put in the floor system from four to five pounds extra metal would be required in the trusses to carry it and that this excessive requirement would render it impossible to build the structure within the limitation of the span-

cial ability of the company and that I did not consider it would in any way detract from the perfectly safe and satisfactory building of the bridge to lower the requirements to those accepted by the first-class railroads throughout the United States.

Q. Were these alterations accepted by the Phoenix Bridge Co. without discussion and were they observed by it throughout the work?

A. As I believe I stated previously, these alterations made by me were discussed with the designing engineer of the Phoenix Bridge Co. This, however, was not for the purpose of getting at their wishes, but to get the benefit of the views of Mr. Szlapka, a brother bridge engineer, upon the suggestions that I was making.

Q. Please state the approximate dates upon which the following operations were commenced:

(a) The preparation of the final plans in detail.

(b) The rolling of the necessary metal.

(c) The fabrication of the metal in the shops.

(d) The erection of the structure into position at the site.

A. Most of these questions will have to be answered by the contractor if exact dates are required; as to the preparation of the final plans in detail, I could give you the dates from the different plans if I had my office plans here, but speaking from memory, I cannot. On Sept. 15, 1903, I received the first plans, the plans for the floor system.

The rolling of the necessary metal undoubtedly commenced as soon as they got my approval of the first plans. Of course, that is a presumption; the exact information can be obtained from the Bridge Company itself. While I know they started rolling the metal as soon as they could, my testimony would not be positive on that matter; I simply answer about the latter part of September.

The information as to the fabrication of the metal in the shops would be obtained in the same way; they all followed one after the other. I do not suppose it would be three weeks after I received the plans until the shops were going on the floor system.

The erection of the bridge began on the south anchor arm on July 22, 1905.

Q. Was there ample time between the award of the contract and the beginning of the work in the mills and shops for the preparation of the construction drawings? Do you consider that sufficient time was given to the study and preparation of the drawings, and, if not, for what reasons was this time curtailed?

A. The Phoenix Bridge Co. practically had the contract for the construction of this bridge several years before they commenced the preparation of the plans. I urged them at an early date to prepare their studies and plans as far as possible for the accepted 1,800-ft. span, for which no plans had yet been prepared, stating that in an important work like this very cautious and very careful consideration would be required in each and every individual detail of the structure and that this should be done before the rush of construction would come upon us. They gave this no attention and practically made no steps towards preparing the plans until they had completed their financial arrangements and had executed their present contract as I believe dated June 19, 1903.

There has not been time enough given, in my opinion, to the careful study and preparation of the drawings and plans of this structure, free from the rush and push of its practical execution. As I understand it, the time stated in this contract for the completion of the work, as verbally given me by Mr. Deans at the time, is three years. I protested against that and stated it was an absolute impossibility to construct that bridge in three years, that under the most favorable circumstances without considering any contingencies, four years at least would be needed, and, in my judgment, five at least should have been asked for. I told Mr. Deans at that time that this meant rush and hurry and the impossibility of giving thoughtful and careful consideration to every step before undertaking the work in the shop. The urgency and demand of the manufacturing side of this problem have, in my opinion, outweighed and burdened the technical and thoughtful consideration of all the plans.

Q. What organization existed for the checking of the strain sheets and detail plans prepared by the Phoenix Bridge Co.?

A. My own office organization absolutely.

Q. At whose expense was this organization maintained and was it sufficient for the purpose?

A. At my own expense, and it was not sufficient for the purpose considering the other duties which were imposed upon me improperly.

Q. Was this work properly part of the duties of the consulting engineer?

A. I so considered it to be.

Q. Was it found necessary to order alterations in the plans prepared by the Phoenix Bridge Co. in any important particulars and, if so, what were the principal alterations made?

A. Yes, numerous and comparatively minor alterations were frequently called for when the detail plans did not fully come up to the requirements. The most important alteration, however, was that of the long eye-bar chord of the anchor arm. It was about the first of June, 1904, that the Phoenix Bridge Co. submitted their plan and arrangements for the top chord and diagonals of the anchor arm. After careful personal examination I declined to approve it as having violated the requirements that I had stated in a personal conference with the engineers and proprietors of the Phoenix Bridge Co. I should demand. At that conference I stated that I would accept no bars exceeding 2 ins. in thickness unless it was an absolute necessity to use a greater thickness. My experience had proved to my mind that when that thickness was exceeded satisfactory bars could not be obtained. In this plan submitted for the top chord they had used bars 2½ ins. in thickness and other prohibitory thicknesses, and they had arranged the bars at angles which were, to my mind, thoroughly unsatisfactory and I called for a new design.

Mr. Szlapka came and had a personal interview and protested that it could not be made better, that he had had his best men on it for two months and he could see no change that could be made in it that would come nearer to my requirements than this plan. I stated I never would approve it and finally I was compelled personally, although it was work I had not done for twenty years, to redesign the whole system. It was a very arduous and trying work and when I was through I was thoroughly exhausted. I gave them a copy of my design and stated that it was not the best that could be done, but that it was the best that I could do, and I hoped now they would take the matter up from the point of view of the changes I had made and still further improve it in certain details which I pointed out.

It was in early June that I first took up the question of this eye-bar chord. While I was working on this chord, on July 10, Mr. Szlapka brought me a new packing which I refused again to approve, and it was not until July 31 that I succeeded in getting from the Phoenix Bridge Co. a satisfactory chord packing in conformity with my views and requirements.

Q. Were the plans finally approved to your entire satisfaction or would you have given them further study had you been able to do so?

A. I should have been glad to have had the physical strength and the time allowed me to have given further study to many parts of this structure, but in my physical condition I have been compelled, and must accept the responsibility for the same, to rely to some extent upon others. I had and have implicit confidence in the honesty and ability of Mr. Szlapka, the designing engineer of the Phoenix Bridge Co., and when I was unable to give matters the careful study that it was my duty to give them, I accepted the work to some extent upon my faith in Mr. Szlapka's ability and probity.

Q. What organization was created to see that proper material was secured for the construction and that the shop work was in all particulars up to the requirements of your specifications and in accordance with your instructions?

A. There were inspectors appointed at the mills to inspect the crude material as rolled to see that it was up to the specifications and requirements. There were inspectors at the shop to inspect the mechanical work and to see that all the details complied with the approved drawings.

Q. Was this inspection properly part of the duties of the consulting engineer and was the organization of this inspection in accordance with your advice? Were you satisfied that the inspectors appointed were, in all respects, the men best qualified for the position; and if not, why and by whom were they appointed? Was your advice with regard to the local force required for inspection and charge of erection asked or did you find it necessary to offer advice on this point? Was this advice followed?

A. It was not properly the duty of the consulting engineer and the organization was not in accordance with my advice. Long before any work of construction was started at the shops the chief engineer of the Quebec Bridge Co. asked me in regard to the matter of the inspection and I outlined the following program, stating that the inspection of the shop work on this structure was far greater and more important than anything that we had had experience with before, that the features of the mechanical work were minor ones compared with the necessity of watching all the technical features of the plans, and that technical engineers, if possible with shop experience, who could not only inspect this work in the mechanical requirements, but see that all the technical requirements of the plan and strain sheets were properly executed, should be employed. I expressed a desire that technical graduates should be appointed to the position of inspectors at the shops. I pointed out that after the erection work commenced we would need a highly developed class of men to take charge of that part of the work; it would be very responsible and very difficult to undertake, and that I hoped we could gradually weed out from those who were at the shop men who were competent to take charge of the inspection of the erection after it commenced. I also pointed out to the chief engineer of the Quebec Bridge Co. that when this bridge was done and finally completed and turned over to the proprietors it would be necessary to have a competent body of engineers to have charge of the structure, its maintenance and general supervision, and that such men should be men who were thoroughly acquainted with the whole history of the construction, the whole theory of the work, and who would be able to know the thing as intimately as possible in order to maintain and take care of the structure properly. I stated that in view of this matter I thought it would be fair and proper that, if it were possible, these inspectors should be Canadian graduates of Canadian institutions, because I stated that the men having charge of this work would have to be there and they should be men of the country.

I did not feel that Mr. Hoare was in sympathy with this matter, and I did not succeed in obtaining at that time the men I hoped for. At a conference at Phoenixville about the time the work was under way, the necessity of an inspector became imperative and I stated that I was hampered, that the men's names that Mr. Hoare had sent me did not satisfy me sufficiently to have me recommend them and that I had no real right to take up that matter. Mr. Reeves, the president of the Phoenix Bridge Co., stated at that time that Mr. Edwards, who is the present inspector, had been an inspector at their shops for many years, and that they considered him a very competent man, that he was persona grata and that he would recommend me to give him consideration. I had Mr. Edwards come to my office and examined into his history and found that some seventeen years before he had done some inspection for me that was satisfactory and that he had been constantly an inspector from that time on and I appointed him inspector at the shops and so reported to Mr. Hoare.

Later on, feeling the necessity of having some one qualified for the inspection of the erection and failing to get any such person appointed, I heard of Mr. McLure, bridge inspector at that time on the New York, Ontario & Western Railroad. I sent for him and examined into his career. I found he was a technical graduate. I inquired into his ability to climb and his ability to express himself clearly in regard to technical matters, and I concluded that he was a desirable candidate for the position of inspector for the erection. I again took the initiative and appointed him assistant inspector at the shops, telling him what my ultimate purpose was, that if he proved himself, after a trial, competent, he should be the inspector of the erection. I sent him to the shops under instructions that while he was to give sufficient attention to the mechanical inspection to make himself thoroughly acquainted with the construction of the work, he should bear in mind that the principal duty that I wanted him to prepare himself for was that of inspecting the erection, that I wanted him to make himself thoroughly acquainted with all the strain sheets, not only of the work as it would finally be constructed, but especially the strains due to the erection, that I wanted him to be so prepared that when he went to the bridge he would know under every change daily made in the load what the effect would be upon all the members of that structure theoretically, and that it would be his duty to see that they practically met the expectation of the theory. I explained to him in a general way the camber necessity, the changes of position of the different members and the necessity of keeping careful and watchful eye on these actions and to know why these modifications were expected, and, when they did not occur, to find out why. I then privately requested Mr. Szlapka, the designing engineer of the Phoenix Bridge Co., to give me all the aid he could in educating Mr. McLure for the position and confidentially to give me his opinion of Mr. McLure's capacity after he had been there a sufficient time to determine it. Later on Mr. Szlapka reported that he found Mr. McLure very energetic, very active, very bright and thoroughly capable of undertaking the work that I had in view.

I reported the appointment of Mr. McLure to the chief engineer of the Quebec Bridge Co. (Mr. Hoare). The general impression left upon my mind after communicating with Mr. Hoare, was that he did not want Mr. McLure. He even stated that he had other men in view. The work of erection had progressed to the extent of placing nearly all the lower chord of the anchor arm upon the false work before Mr. Hoare called for Mr. McLure's assistance. He had previously to that, I would state, forestalled my action after I had appointed Mr. McLure by notifying me that he had appointed Mr. Kinloch inspector for the erection. Without any reflection upon Mr. Kinloch—all I have heard of him has been most favorable—I knew he was not qualified to do the duty that I expected of the inspector of erection. When Mr. Hoare sent for Mr. McLure finally, they were wedging out the lower chord for camber, something that I am thoroughly satisfied neither Mr. Hoare nor Mr. Kinloch understood. I think that was the reason for calling for Mr. McLure at this late day. Knowing that Mr. Hoare had already appointed Mr. Kinloch inspector for the erection, I felt it my duty to put Mr. McLure's position clearly to Mr. Hoare, so I gave Mr. McLure a letter of instruction and addressed him as inspector in charge of the erection, Quebec Bridge. I told him to present that letter to Mr. Hoare when he went to Quebec.

Q. How often did you personally visit the shops and by whom and in what form were instructions given to the inspectors?

A. I am sorry to say after the work commenced I visited the shops I think but three or four times. I do not know to what extent Mr. Hoare may have given the inspectors instructions; I have given them from time to time verbal and written instructions. The shop inspectors' instructions have been almost entirely verbal except on occasions when things would come up about which I felt it necessary to write a letter to the shop inspector. He was in the habit of coming to my office at least once a month, sometimes twice, but always once a month, to bring estimates of weights of material for my examination and approval. At such times he furnished me memoranda showing what had been done and also drew my attention to points on which he wished my advice and instruction, so that largely my advice and instructions to the inspector at the shops were verbal.

As to Mr. McLure, I know not what instructions he may have received from the Chief Engineer of the Quebec Bridge Co., but all my instructions to him while he was on the work were in the written communications of which the Commission have full copies.

Q. Were the records from the inspectors regularly transmitted to you and to whom did they refer for instructions in case of dispute or difficulty?

A. I think that is already answered except in regard to the records. Mr. Edwards made both verbal and written reports from time to time. Mr. McLure made regular weekly reports in regard to the work of erection and to the best of my knowledge and belief, in all cases of dispute or difficulty I was the only person from whom they received any instructions.

Q. Was the workmanship satisfactory to you, or did you find it necessary to take decided action to secure satisfactory results?

A. In many directions the workmanship was perfectly satisfactory, but I had cause to make frequent complaints of the mechanical department, especially regarding the facing of the compression members and the boring of the pin holes.

Q. Did you find it necessary to take decided action to secure satisfactory results?

A. Unfortunately I did not know the unsatisfactory results until after they were made. I did frequently and strongly express my dissatisfaction with the faults that were made, and I did also require that all such faults should be corrected to put the work into a satisfactory shape. Whether that was done I have no personal knowledge except the reports from the Phoenix Bridge Co. and the inspector.

During the erection, on June 2, 1906, Mr. McLure reported that when preparing to erect the center posts he found the bearings of the upper parts of this post were not true and straight and sent me sketches which indicated very bad shop workmanship. I instructed him to stop the erection until this was properly corrected and remedied. He reported later that this work had been corrected in accordance with my instructions. Of course, I do not recall, and it would be perhaps unnecessary, each individual case where errors occurred. They are all on record and can be found from the files, but I could not refer to them without devoting a good deal of time to going over the records, and I do not think it would be important in the line of testimony except to show that the workmanship was not entirely satisfactory to me, especially that part that I have mentioned.

Q. Are you fully satisfied with the steel that has been supplied for this bridge and does its action both when under test and in the wreck indicate thoroughly good material?

A. I think it has been shown both under tests in the testing machine and the test of the failure, as far as I can judge by the reports of the failure, that the material is unquestionably most excellent.

Q. Did the magnitude of the structure call for much better workmanship than is usual for ordinary bridges and was any effort made to secure such superior workmanship? Was the workmanship defective in any particular?

A. I most decidedly think it did demand a higher class of workmanship than that employed in ordinary bridges and I do not think that in all matters proper efforts were made to secure such workmanship, particularly in reference to the two points I have previously mentioned, the facing of the compression members and the boring of the pin holes.

Q. Who devised the method of loading and unloading the members and all provisions for transportation, and under what supervision was this work carried on?

A. It was entirely within the hands and under the control of the Phoenix Bridge Co.

Q. Was the deformation of these members while in transit probable?

A. Yes, under careless treatment or in the case of accidents.

Q. Whose duty was it to ensure that the erection methods and appliances were suitable to the work and to organize the system of erection?

A. The Phoenix Bridge Co.'s. At the same time I had in a general way, but not in detail, to consider the methods they intended to employ and I believe that great care was employed by the Phoenix Bridge Co. in devising an excellent method of handling the material and putting the same in place.

Q. Was the inspection of the work of erection and the taking charge of that work properly part of the duties of the consulting engineer and, if not, whose duty was it?

A. It was not the duty of the consulting engineer. It was the duty of the Chief Engineer and his organization, with the sole right to apply to the consulting engineer for advice upon any special problem.

Q. Was the local staff at Quebec, employed by the Quebec Bridge Co. and the Phoenix Bridge Co., to your satisfaction, and did you consider it fully competent to handle the work?

A. Not from my present knowledge. When discussing the necessity of technical men for the inspectors I took the matter up with the Chief Engineer of the Phoenix Bridge Co. and pointed out to him not only the necessity of the Quebec Bridge Co. having competent men in charge of erection, but also the absolute necessity for the Phoenix Bridge Co. to have an engineer on the work at all times who was fully cognizant of the details of the structure, the action of the different members under the different strains and camber movements and who would have the technical knowledge to take action if, at any time, the theoretical expectations should not be obtained, to determine why such result was not obtained and be able to direct the necessary corrections. I do not think, from my present knowledge, that the Phoenix Bridge Co. did have any such engineer upon the work.

In regard to the local staff of the Quebec Bridge Co., I have no knowledge further than in reference to the Chief Engineer and Mr. McLure, and I feel now that on the part of the Quebec Bridge Co. Mr. McLure was the only person who had any preparation or qualifications for supervising the construction of that bridge, and I know that the time allowed him for preparation for this important duty was not as great as should have been given him. From the reports that he has from time to time sent me, from personal intercourse with him, I feel that he did all that could be expected of him under the circumstances.

Q. By whom were its members appointed and to whom were they responsible?

A. I have already explained the method of the appointment of Mr. McLure, the only one in regard to whose appointment or selection I have any knowledge.

Q. By whom was this force paid?

A. I presume by the two companies, that each company paid the staff employed by it at Quebec.

Q. Please state what qualifications in the way of training, age and experience were necessary to make a man fit to have supreme local control of the erection of this bridge and whether any of the staff employed by either the Quebec Bridge Co. or the Phoenix Bridge Co. had these necessary qualifications?

A. For a man to be qualified, in my opinion, to have the supreme local control of the erection of a bridge as important as that under consideration, I think he should have been a thoroughly technically educated and experienced bridge engineer. I regret to say that I do not think the Chief Engineer of the Quebec Bridge Co. had these qualifications. In reference to the local control by the Phoenix Bridge Co., as stated before, I do not think they had the quality of engineer that the circumstances demanded. In saying this I do not wish to reflect in any manner upon Mr. Birks, who sacrified his life and who undoubtedly was a competent man in his line of experience; but I do not understand that he had the thorough training and knowledge of all the requirements of this structure necessary to fit him for the responsible position as the engineering representative of the contractor on such an important structure.

Q. Is it reasonable to expect that emergencies of grave importance may arise upon work of such character and magnitude and could the local staff of the Quebec Bridge Co. be considered to be reasonably complete without including an engineer of sufficient scientific training, age and practical experience to be competent to deal with any such emergencies?

A. I have practically answered that already. I do think that emergencies of grave importance are liable to occur in the erection of such a great work and the history shows that they have occurred, and, as I stated before, I do not think that the local staff contained a man of sufficient training, age and practical experience, to have met the emergencies.

Q. To what do you attribute the employment of a staff not equal in caliber to the difficulties of the undertaking, on the part both of the Quebec Bridge Co. and of the Phoenix Bridge Co.?

A. This is a rather difficult question for me to answer. I suppose that in the case of the Quebec Bridge Co., like all projects undertaken by men not specially acquainted with the necessities, the engineering features of any such great work, they were unable to make a proper selection. In reference to the Phoenix Bridge Co., I think it was due to the fact that the commercial branch of that company gave more consideration to the pushing and completing of the work than they did to the giving of due consideration to the practical requirements of such a great structure.

Q. Do you consider that it is wise practice when building a bridge of novel character and unprecedented dimensions to place the design of the structure and of the methods of erection in the hands of the mechanically trained staff of a contracting company and, if not, why was this practice allowed in this case?

A. In answer to this question, it is the general practice in America to have the mechanically trained staff of contracting companies prepare the working plans. As a rule, no engineer could afford to maintain a staff of such character and no corporation would listen to a fee that would cover any such expense.

Q. Were the methods of erection submitted to you for approval or were you in any way advised of these methods and of the character of the plant that was being provided for the erection?

A. They were submitted to me unofficially, not for my criticism, nor that they came within my authority, but for personal interest.

Q. What authority had the engineers and inspectors of the Quebec Bridge Co. to order changes in these methods or to interfere with the progress of erection?

A. They had all the authority that belongs to a chief engineer and his staff, the authority that belonged to their offices.

Q. Was it fully understood that the execution of this work was at all times subject to their approval?

A. I think that is implied in the office of Chief Engineer. In my instructions to Mr. McLure, as far as his authority went, he was distinctly instructed to see that no undue risks were taken and that all the work was satisfactory before it was finally left.

Q. How often did you visit the bridge site during the erection of the superstructure?

A. Never. I have never been able to visit the bridge since the erection commenced. I was disabled before that was undertaken.

Q. By whom and how often were you advised of the progress of the work and of matters of interest connected with it?

A. Mr. McLure made me weekly reports detailing pretty clearly, and apparently thoroughly, the progress and the occurrences of the previous week and he occasionally sent me an additional special letter when something would occur that he thought should have more prompt attention than a matter contained in the weekly report.

Q. Did you find it necessary to interfere with the conduct of the erection and if so, what were the circumstances of such interference?

A. As narrated in a previous answer I stopped the erection of the center post until it was made satisfactory.

In the latter part of September, 1906, on receipt of Mr. McLure's letter of September 22, 1906, and letters following, it was made clear to me that the anchor arm was not acting in accordance with the theoretical expectations. On studying the detailed reports of Mr. McLure and the levels contained in his reports I found that instead of the anchor arm working itself free from the false work near chords 8, 9 and 10 first, as it should have done, it was showing a tendency to lift at the far shore end. This was so anomalous that I sought for the reason thereof and I came to the conclusion that they had not considered the compression of the main center post under the additional load of the cantilever arm; that this was throwing an undue load upon the bents near point 9 of the anchor arm, and without giving at that time, Sept. 24, any positive orders, I drew Mr. McLure's attention to this point, believing that he and the engineer of the Phoenix Bridge Co. were also watching for these contingencies and would take the proper action to remedy the difficulty.

It appears that nothing was done by the Phoenix Bridge Co. until several weeks later when, in an interview with Mr. Szlapka at my office, I showed him the correspondence between Mr. McLure and myself and pointed out what I considered to be the difficulty. He acknowledged the theory upon which I was working and I believe that he that day did send orders to Phoenixville to take the proper steps to relieve this undue strain at this point.

There was some friction between Mr. McLure and the superintendent of erection in reference to this matter, which will be found in the correspondence, indicating that the Phoenix Bridge Co. did not recognize the rights of anybody except themselves to control the erection. That point was brought up in a later discussion with Mr. Szlapka in an amicable way and I distinctly told him that the Phoenix Bridge Co. were not the only parties who had financial interest in this structure, that the parties whom I represented, the Quebec Bridge Co., had paid for the structure as it stood, that it belonged to them and they had an interest in seeing that it was not risked or injured and while I always endeavored to get along amicably with everybody, if it came to a point of determining my right or the right of any employee under me to protect the property of the company, I thought they would find themselves in the wrong. I think the

correspondence will further illustrate all that without my going further on that point.

Q. Do you think that the leaving the position of this chord at that time, with the falseworks not lowered to their proper position, could have produced any injurious effects near or about lower chord 9 of the anchor arm?

A. That an undue and an unprovided-for strain was produced by this neglect seems very possible to my mind, especially considering that at that time the splices, which were the weakest and most hazardous portions of the structure, were not riveted and perhaps not fully and properly bolted.

Q. Was appeal to you for assistance and advice in the face of difficulties ever made by the Phoenix Bridge Co.?

A. That I suppose I could answer by saying that Mr. Szlapka and myself were in frequent intercourse discussing and considering many points as they occurred.

Q. Was it the practice of the Quebec Bridge Co.'s staff to refer all difficulties to you, and, if so, what were the duties of the Chief Engineer?

A. As far as I know all difficulties, all questions, all decisions on any matter relating to the structure were referred to me and practically, as I now see it, I was acting not only as the consulting engineer, but as the chief engineer of the Quebec Bridge.

Q. What was the agreement between yourself and the Quebec Bridge Co. as to your remuneration for your personal services and expenses and under what circumstances was the original arrangement amended? Did the Quebec Bridge Co. allow you anything for the necessary staff of assistants? What proportion of your fee have you had to expend for assistance in the interest of the Quebec Bridge Co.?

A. At the original interview where I made the offer to undertake the examination of the competitive plans I was asked what my fee would be to act as consulting engineer when the work was started. I stated that my fee would be $7,500 a year for such services. I did not recognize at that time that there was to be any expense except an occasional visit to Quebec, so that I made no agreement regarding expenses. In August, 1901, being in Quebec and my fees backward in payment, finding that the company apparently were embarrassed for funds and considering that under the circumstances then before me it might be some years before any actual and important work would be required from me as consulting engineer, I wrote a new offer which amounted to reducing my fee to one-half. A member of the Board suggested at that time to make it the round sum of $4,000 instead of the one-half which I had offered. That amount has been paid to me up to the commencement of this year.

When other duties than those of the consulting engineer began to be placed upon me I suggested to Mr. Hoare that it was hardly fair, considering that I had reduced my fee to one-half, that I should not be granted some additional remuneration to aid me in carrying out the duties that had been placed upon me. No such additional remuneration has ever been granted me and no offer has ever been made to restore my original fee. My staff and office expenses due to the work required in the interest of the Quebec Bridge Co. have been paid entirely from my own fee and they have amounted to approximately the sum that I have received from the Quebec Bridge Co. to cover my employment.

Q. Did the officers of the Phoenix Bridge Co. fully appreciate the engineering difficulties connected with the undertaking and did they willingly and immediately make good all defects that were brought to their notice?

A. I think the technical staff as represented by Mr. Szlapka and his subordinates did fully appreciate the engineering difficulties connected with this undertaking, but I do not think that that branch which might be called the commercial side of the Phoenix Bridge Co. were willing to or did make good defects that were brought to their notice until they were compelled to, when compulsion was applied.

When the elongation of the eyes of the eyebars under the strains that we were intending to employ was brought to my notice by certain preliminary tests, feeling it to be a matter of serious moment to know the truth, I urged the Phoenix Bridge Co. to make a thorough investigation of this subject and suggested to them that as it was a matter of special interest to all bridge construction, they should enlist the cooperation of other bridge companies in making a thorough examination into the whole problem. After more or less discussion it was made clear to my mind that the Phoenix Bridge Co. were more desirous of hiding the matter than they were of exploiting it. I was asked not to make the matter public. Finding this to be the position, on Jan. 8, 1905, I wrote to Mr. Edwards, the inspector at Phoenixville for the Quebec Bridge Co., directing him to accept no more eyebars for the Quebec Bridge until further orders and directed him to furnish a copy of this letter to the Phoenix Bridge Co. Then the Phoenix Bridge Co. showed eagerness to carry out the investigation that I demanded and did carry it out to my satisfaction.

In other matters from time to time I did find them sluggish in making corrections or remedying defects. To come down to a later date, on Aug. 6, 1907, Mr. McLure reported the condition of chord 7 and 8 cantilever arm and the method of remedying proposed by the Phoenix Bridge Co. Upon the receipt of this letter from Mr. McLure on Aug. 6, I immediately telegraphed the Phoenix Bridge Co. that the method was not satisfactory and asked them: "How did this occur?" The subsequent correspondence containing my letters to Mr. McLure and Mr. McLure's letters to me, my correspondence to the Phoenix Bridge Co. and their replies to me, all of which are consecutive, indicates that the Phoenix Bridge Co. did not desire to make any corrections of importance, did not desire to put this chord in a safe condition, tried to convince me that the error was unimportant and even tried to explain that the error had always been there. Before I could take final action as I had fully prepared to do at the time, the more serious problem of the bending of chord 9, anchor arm, was reported to me.

Q. Was due care exercised throughout in the handling of the bridge members?

A. For that information, gentlemen, you will have to depend on the testimony of other persons. I judge, however, from results reported to me, that there was not due care at certain times.

Q. Are you aware of any cases in which members were damaged in handling?

A. It is now before the Commission in evidence that chord 9 was damaged in handling.

Q. Are you aware of any cases in which the connections between members in place were not fully made?

A. It would appear from the evidence and from the records of Mr. McLure, that the splices of the lower chords were not fully made or properly considered.

Q. What deviation of a rib of a main compression member from the straight would be passed in first-class inspection and what variation from the true plane is permissible in the faced ends of the ribs at butt joints?

A. It is impossible to draw any general and definite rule that applies to all cases. There must be a certain amount of engineering judgment applied to each special case, but I should consider that in a general way, bearing in mind the compression chords of this structure, that any deviations from a straight line corresponding to the axis of the member exceeding half an inch would not be good and if this amount of deviation is only for a short length it becomes far more serious. In regard to the amount of error that might be permitted in facing the ends of compression members, bearing in mind the large dimensions of those in this structure and the importance of having the best workmanship on account of the high demands made on all parts of the structure, I should think that one sixty-fourth of an inch variation from a straight line on the full width of the lower chord would be the extreme limit that should be permitted.

Q. Where these limits have been exceeded in the Quebec Bridge members do you consider that the fault lay with the shop inspection or that the distortion might be due to insufficient care in handling?

A. Both or either.

Q. Would such faults materially weaken a compression member?

A. Any departure from a perfect fit or straight line in a compression member does weaken that member. How much, of course, depends upon the relative departure from the true lines.

Q. Was the progress of the riveting such as you desired that it should be at the various stages of erection?

A. To the best of my knowledge it so appeared.

Q. Why was the south half of the suspended span to be erected in 1907 when the north half, in all probability, could not be erected until 1909?

A. Simply because the material was there, the tools were there, and it was undoubtedly perfectly proper to complete that portion of the work while they had it in hand, everything else being satisfactory.

Q. Was your approval of this procedure requested or obtained and, if not, was this procedure in your judgment good practice?

A. The matter was discussed and I considered it perfectly proper and good practice.

Q. Who authorized the commencement of the erection of the suspended span before the large traveler was taken down? Was it understood that this was to be done and did this procedure have your approval?

A. In the early stages of the erection, long before the large traveler was passed over to the cantilever arm, I drew Mr. Szlapka's attention to the undesirability of using the large traveler for erecting the suspended span, pointing out that it was unduly hazardous and was unnecessary for various reasons which we discussed. He agreed with me and agreed to have a small traveler designed for the purpose of erecting the suspended span. The small traveler was designed and they then appealed to me that it would be necessary to use the large traveler for the purpose of erecting the small traveler into position. I gave my consent to that being done, but it was clearly understood that as soon as the small traveler was erected, the big traveler would be removed from this structure and that the erection of the suspended span would be continued with the use of the small traveler only. I was under the supposition that the large traveler was being taken down. [illegible] they had commenced to take it down, and I was [illegible] astonished when I found that they were [illegible] erection of the suspended span with the use [illegible] traveler and most of the weight of the large [illegible] at the extreme point of the cantilever arm. [illegible] edge, however, only came to me after the [illegible] of the structure.

Q. From your present knowledge what do [illegible] consider the weakest and most hazardous part of the [illegible]?

A. Unquestionably the splices of the [illegible] chord. While, from the appearance of the wreck [illegible] splices when properly and fully riveted were the st[illegible] est part of the compression chord, when unriveted or [illegible] properly bolted they were in a condition of great haza[illegible] and uncertainty. As these splices in the anchor arm [illegible] ould not be riveted until the camber action had taken [illegible] ace and the joints had come to full and proper bea[illegible], they were, if improperly stayed and bolted, very [illegible] ngerous points and should have been most carefully wa[illegible]ed and protected. From the report of the condition [illegible] splice 7-8, cantilever arm, which is contained in Mr. McLure's and other correspondence following Aug. 6, 1907, there was first made clear to me the seriousness [illegible] these splices and the lack of appreciation of the necessary care to be given them by the Phoenix Bridge [illegible].

Q. Do you consider that the initial failure took place in the lower chord?

A. I feel thoroughly satisfied, with the history now before us in regard to chord 9, west, anchor arm, that it was the initial point of failure.

Q. Were you satisfied with the care and intelligence shown by the Phoenix Bridge Co. in placing the members of this chord?

A. I think I have answered that already when I have spoken of their lack of caution in staying and protecting the splices of this lower chord. With the facts before us, seeing their lack of appreciation and consideration of the splices at 7 and 8, cantilever arm, there is grave suspicion in my mind that similar neglect and lack of appreciation may have prevailed before.

Q. At what date did you first become uneasy about the lower chord members?

A. On Aug. 8, 1907, upon the receipt of Mr. McLure's letter, as I have before mentioned, narrating the condition of splices in chord 7-8, cantilever arm.

Q. Starting from this date please relate all the circumstances in which you were personally concerned up to the time of the failure, referring to all communications that reached you and all action that you advised.

A. I have already stated and drawn your attention to the correspondence between the Phoenix Bridge Co., Mr. McLure and myself, following Aug. 6. On the morning of Aug. 29, on reaching my office somewhere about 11:25 o'clock, I found Mr. McLure at the office. After speaking to him I passed to my office and took up my morning mail, among which was the communication of Mr. McLure narrating the condition of chord 9, west, anchor arm. After carefully reading and considering the letter I called Mr. McLure into my office and cross-examined him to find out whether the facts given were actual or whether he had been scared, and satisfying myself that the data there were from actual measurement and actual observation, I said: "It is very serious." He said: "Mr. Cooper, they have moved out the small traveler, but we have estimated that it will not add to the strain on chord 9 more than 50 lbs. per square inch, but they are going on this morning to erect more of the work; do you think that is right?" I said: "By no means right."

I said: "Is Mr. Milliken on the work?"—intending to immediately telegraph orders to Mr. Milliken to stop it. "No," he said, "Mr. Milliken is not present on the work; there is only a foreman present." "Well," I said, "I do not know whether a foreman would take a suggestion from me or not; I will have to telegraph immediately to the Phoenix Bridge Co. for them to wire to the bridge."

I said: "Are you sure that the Phoenix Bridge Co. have these same facts before them that you have presented to me?" And he said: "Exactly the same report has gone to Phoenixville that you have now received." That was confirmed by a telegram handed me about the same time from Mr. Hoare, stating that Mr. Hirks had received a telegram from Phoenixville stating that this chord had been bent before it left the shop. Satisfied then that the Phoenix Bridge Co. had the same facts I immediately telegraphed them to "add no more load to bridge till after due consideration of facts."

I then said to Mr. McLure: "You must go to Phoenixville immediately and tell the Phoenix Bridge Co. that I do not want any delay such as that involved in the discussion that we have had heretofore on similar occasions, but I want immediate action to strengthen that chord and to protect the bridge." He pulled out his time table and said: "Mr. Cooper, I cannot reach Phoenixville before five o'clock." I then added to the despatch: "Mr. McLure will be over at 5 o'clock." Mr. Bergen went to the Western Union office and they had the telegram endorsed: "Sent from the Western Union office at 12.16 p. m."

I immediately took up the problem of how to protect

and how to strengthen that chord and made some sketches which I showed to Mr. Berger. I said: "If the Phoenix Bridge Co. do not themselves adopt some better method I would suggest that to them." At 9 o'clock that evening I was called up on the long-distance telephone and Mr. McLure reported that the bridge was in the river.

Q. When do you think that the first failure took place and in what manner do you think the bridge acted during the fall?

A. Considering the history of chord 9, which is before the Commission, there is no doubt in my mind that chord 9, east truss, failed first, and after it passed a certain degree of flexure the lattice bars in the center of the chord were perhaps what first gave way. To my mind the noise that the men first heard was the explosion of the lattice bars of chord No. 9 at the center. Unrestrained by the lattice the webs of this chord undoubtedly buckled together as so many sheets of paper crushed in the hand. When chord 9 had passed a certain point the lateral braces between that truss and the opposite truss in that panel were disabled from doing any staying duty. It appears to me then necessarily that the opposite chord 9, east truss, must have given way even had it been far stronger than it actually was. With the giving way of chord 9 west, immediately followed by the failure of 9 east, the cantilever arm would naturally deflect towards the river.

The evidence of the wreck, showing the continuity and unbroken condition of the eyebar top chord and that the anchor towers and anchor bars which were vertical in position before rupture were pulled out to a horizontal position, indicates clearly to my mind that the main towers must have remained intact until this was done—indicating that the main towers and the whole of the anchor arm declined towards the river and downwards until either the main towers slipped from their footings or the great strain of this long eyebar chord produced the final rupture of the main towers. That the great mass of fallen material moved several feet towards the east was due to the probable action and later rupture of the eastern truss, which would produce a tendency to drag the material towards the east.

Q. Do you consider that there was clear indication that the failure was imminent and was it possible, by prompt and intelligent action, to have prevented the failure?

A. I think the deflection of an important member, as chord 9 west, to the extent of 2¼ ins. would indicate to any intelligent mind that that chord was less capable of doing the duty that it would have done if in a perfectly straight condition and I do think that it was perfectly possible by prompt and intelligent action to have stayed that chord and prevented the failure of the bridge.

Q. By whom should the orders for such action have been given and to whose lack of judgment and initiative can the failure therefore be charged?

A. To the executive officers of either company who were present or within sufficient touch to have given any orders.

Q. In your opinion is it good practice to leave the ordering of such action to any employee of a contracting company?

A. The contracting company should have had on the structure an employee of sufficient intelligence to have appreciated the necessity for and to have given such an order. At the same time the responsible executive of the Quebec Bridge Co. should not have hesitated, in the absence of proper action by the contractor, to have given such an order.

Q. Do you think that at moderate expense the ribs could have been made absolutely safe?

A. I do. I believe if prompt action had been taken to protect chord 9 west from further deflection, which could have been done by the employment of three hours' work and $100 worth of timber and bolts, the defects and deficiencies which we now recognize in the compression chords and members, could, at a later date, have been corrected and the bridge could have been made perfectly safe and sufficient for its intended purpose.

Q. Do you consider that the engineering data at our disposal are sufficient to enable engineers to design members similar to those in the lower chord with safety and economy? Would you now recommend any material changes in the detailing of these or any other members, and, if so, what would these changes be?

A. My responsibilities, gentlemen, end as soon as I have served my duty of aiding you in reaching the truth in regard to the destruction of this bridge. While I have my views and such views are at the service of those who have heretofore relied on me, I shall decline to take any executive or responsible position in connection with the corrections of the errors that we now recognize in this work; it must be referred to younger and abler men.

THE ENGLISH BATTLESHIP "DREADNOUGHT" is reported "helpless," by the (London) "Engineer." Officially she is reported "preparing for experiments." It is definitely stated that there is no trouble with the turbines.

ORGANIZATION OF THE AMERICAN PEAT SOCIETY.

After some years of intermittent and spasmodic agitation for the organization of those persons engaged in the development of peat deposits, a voluntary committee was organized and invitations were issued for a meeting to discuss the advisability of such an organization. All persons interested, from a commercial or scientific standpoint, in peat lands, for industrial or agricultural utilization, were asked to be present.

This preliminary committee was arranged with Dr. Joseph Hyde Pratt, State Geologist of North Carolina, as chairman, and Mr. Julius Bordollo of Kingsbridge, New York City, as Secretary. This meeting was scheduled for Oct. 23 to 26 at the Jamestown Exposition. About 25 persons attended these sessions and the organization was quickly determined upon. A sub-committee of the preliminary body mentioned before had already been at work on a constitution and by-laws, which were subsequently adopted with some minor changes and rearrangements found advisable. The details of this constitution as adopted can not be given here on account of restricted space. It should be noted that the territory to be covered by this association includes all North America which, for purposes of organization, is arranged into five divisions: Canada; the Northeastern States; the Southern States; the Great Lakes and Upper Mississippi region; the Pacific States. Each of these divisions is to be represented by a Vice-President. The other officers include a President, a Secretary and a Treasurer, who form with the Vice-Presidents, virtually an executive committee. Two classes of membership were provided; active and associate. It is proposed that the active membership should consist of persons actively engaged or interested in peat developments and that the associate members, those who are only indirectly interested in peat questions, but desiring the benefit of the company's publications. The dues were fixed at $5.00 per annum for active members and $2.00 for associates. Members are admitted and classified by the executive committee of officers. The opinions expressed and instructions to the officers were against admitting any persons as associates who were directly interested in peat utilization thus forcing them into the active list. Persons interested less directly, if they so desire, may become, on the approval of the executive committee, active members rather than associates.

The following officers of the American Peat Society were elected for the first year:

President, Dr. Joseph Hyde Pratt, State Geologist of North Carolina.

Vice-Presidents:

(Northeastern States), Marius R. Campbell, United States Geological Survey, Washington, D. C.

(Southern States), Mr. Robt. Ransome of Jacksonville, Florida.

(Great Lakes and Upper Mississippi), Carl G. Kleinstuck of Kalamazoo, Michigan.

(Pacific States), not filled.

(Canada), Dr. J. McWilliams of London, Ontario.

Secretary, Mr. Julius Bordollo, Kingsbridge, New York City.

Treasurer, Mr. Henry G. Halloran, P. O. Box 1816, Boston, Mass.

The business and program sessions occupied Wednesday and Thursday. Friday was given over to inspections of the Fuel and Alcohol Building at the Exposition. Saturday was reserved for an excursion to the Dismal Swamp which is in course of drainage and reclamation and contains notable peat deposits. During the program sessions several papers on the peat industries and allied subjects were read. Some of these are appended in abstract.

Mr. F. J. Bulack, President and General Manager of the Commercial Artificial Fuel Co., of Toledo, Ohio, offered to the society for tests, etc., the free use of the plant of this concern. The plant is centrally located, equipped with dredging, excavating and elevating machinery, buildings and power. An average quality of peat exists there and a small laboratory is connected with the plant. The offer was accepted by the society.

ABSTRACTS OF PAPERS PRESENTED.

THE OCCURENCE OF PEAT.—Mr. Francis J. Bulack of Toledo, Ohio, read a paper on "Peat in Ohio and Michigan." It was stated that little attempt had been made in Ohio for the utilization of peat for fuel as all such lands that had been examined were full of sand and non-combustible matter. One company was reported as having been organized for the manufacture of peat fuel near Dayton, Ohio. It was stated in this paper that the company claims to have 200 acres of peat deposit. The only extensive use of peat lands in this State were stated to be for agriculture. Large beds along the southwest shore of Lake Erie have been extensively drained and used for onion culture.

In the state of Michigan peat was found in nearly every county, with large deposits near Adrian, Tecumseh, Charlotte, Jackson, Kalamazoo, St. Joseph, Muskegon, Grand Rapids, Big Rapids, Port Huron and Bancroft. Very few of these had been found to possess economical drainage facilities as features. Several notable failures in this state were attributed by the author to employment of artificial drying, for which no suitable process had been developed.

PEAT-WORKING PROCESSES.—In a paper entitled "The Peat Industry and Its Possibilities in America," Mr. C. E. Davis, of the United States Geological Survey, Ann Arbor, Mich., presented a general résumé of the peat developments up to the present time, as he had been able to study them. It was stated that the first uses of peat as a fuel by hand cutting and air drying were available only in countries where labor was very cheap and time-saving no object. The early improvements were made in Germany by introduction of machinery. The great problem in economically producing peat fuel was held to lie in the extraction of the 90% of water so that the 10% of combustible might be utilized. Many attempts have been made to filter, force and artificially evaporate this excess of water. The history of American peat projects was described as discouraging, partially because of the repetition of mistakes, of the employment of doubtful processes, lack of knowledge of the properties of the particular deposits and in some cases irresponsible and even fraudulent financing. American deposits had been found of extremely varying structure and composition and a large proportion of abandoned projects were known to have a deposit unsuitable to yield a fuel of the characteristics of the one exploited or suitable to be worked by methods proposed.

The author held that there was no great widespread field for peat fuel, but that a supply would be found desirable in small broadly scattered districts, in relatively small amounts, and in larger amounts in greater areas where there are available deposits far from a coal supply. The future development, the author expected, would be along the lines of peat producer-gas, more successful means of drying and briquetting, peat charcoal and coke, peat paper and pasteboard, a deodorizing stable litter, a carrier for certain agricultural fertilizers and in the development of peat deposits as agricultural lands. In the paper on peat in Michigan and Ohio, by Mr. F. J. Bulack, mentioned above, some material was given, on the practical processes, which is abstracted briefly here instead of under the class indicated by the title of the paper. It was the experience of the author that artificial drying had been a mistake and was inherently impractical and uneconomic in the United States. He had found the wet process successful—grinding, macerating, and kneading the wholly or partially decomposed wet peat and forcing or forming it into oblong or cylindrical blocks 4 to 12 ins. long by 2 to 4 ins. thick, dried on pallets and racks in the shade. A great former source of trouble seemed to have been in the idea of removing the water too quickly. In the author's experience the hardest and densest peat came from blocks so wet that they could hardly hold their form when first made. It was stated that air drying left a great deal to be desired; storms caused great damage

and the cost of pallets and racks greatly increased the investment. Some localities, like some parts of Michigan, with an average humidity of 40% and an ordinary maximum of 92-100% could not allow the production of a natural dried peat on paying methods unless a more successful artificial drying process should be brought out.

Dr. P. McWilliams of London, Ontario, in a paper on "Peat Drying," announced a semi-artificial process which had been developed and carried to successful commercial operation, but which heretofore had been given only local or slight publicity. After a short general discussion of the presence of the water between the fibers and in the cells of the peat itself, and of the successful combustion of peat fuel containing up to 30% of moisture, the interesting point of the new process was brought out.

It appeared that, during the experiments of Messrs. W. C. Milne & Sons of Hamilton, Ontario, it was actually determined that peat, exposed to air of the ordinary summer temperatures and humidities prevailing in that locality, dried to a depth of about a quarter of an inch in two hours, but that it required over two weeks to dry it to a depth of one inch. By drying was meant a reduction of moisture to some 25 or 30%, which seems to be the limit of natural evaporation. From this discovery a method was developed which was briefly outlined as ploughing, harrowing and, after two hours, sweeping up in a proper elevating machine the quarter-inch of dry peat. This was passed through a steam dryer where it attained a temperature of some 100° F. From here it passed through an aerating dryer where it attained a temperature of some 170°. It was then compressed into briquettes without the addition of foreign matter. It was possible in three hours' time after the levelling of the peat, containing 90% moisture, to bring out sacked briquettes. A quantity of briquettes were exhibited and seemed to be extremely durable and weatherproof. A ready local sale had been found up to the capacity of the plant built. The local price of anthracite was from $7 to $8 and that of soft coal about $3 per ton. The briquettes were sold at a profit for $5 per ton.

"Draining and Value of Peat Lands for Agriculture," was the title of a paper by Mr. S. M. Woodward of the Department of Agriculture, Washington, D. C. The origin of drainage was ascribed to the farmer who attempted to unwater his deluged crops, by the most primitive methods. It had grown from such beginnings to the reclamation of wet lands which 30 years ago were not worth draining. Peat on river-bottom lands where silt could accumulate had been proven good agriculturally. The purer the peat and the less the amount of intermixed or interposed silt the more difficult was the working of such lands.

In unwatering such lands parallel ditching had proven futile and success lay in locating and cutting off the source of supply. Peat lands were not to be allowed to become too dry and for the amount of water to be admitted careful provision was necessary. Thus far the work on peat lands had been directed toward drainage and fuel possibilities and little had been brought out on the producing powers of such soils. It was stated that greater financial possibilities existed probably in developing a peat deposit for fuel, where possible, than for agricultural uses, but even after the fuel deposits had been exhausted it was probable that the agricultural uses were unimpaired. It was stated that 100,000 acres of peat lands in northern Wisconsin were under drainage for agriculture, and that along the Santa Ana River, California, were similar lands.

THE ZEIGLER PROCESS FOR MAKING PEAT-COKE.—This process consists in carbonizing peat in upright retorts. A coke is produced of a chemical composition similar to carbon and one equal to coal-coke in hardness. The analysis of samples of peat-coke made by the Zeigler process and a comparative analysis of charcoal are shown in the following table:

COMPARATIVE ANALYSIS OF PEAT-COKE (ZEIGLER PROCESS) AND CHARCOAL.

	Peat-Coke.	Charcoal.
Carbon	87.8%	87.6%
Hydrogen	2.0%	3.1%
Nitrogen	1.3%	0.4%
Sulfur	0.3%	0.3%
Oxygen	5.5%	4.7%
Ash	3.2%	0.9%
Water	0.0%	3.0%
Heating value:	14,500 B. T. U.	

Peat-coke has proven in Germany an excellent substitute for anthracite and can replace charcoal in any processes. It seems to have a good field in the iron and steel industry especially where products of a high ultimate strength are required.

The Zeigler process recovers the by-products of the dry distillation. Those retained in tar-water are finally obtained as ammonium sulphate, lime acetate, methyl alcohol, etc. These were stated to have a well established market with an increasing demand. The products contained in the tar recovered are light and heavy oil, paraffin, creosotic oil, carbolic acid, asphaltum, etc. The crude peat-tar has been advantageously used for impregnating timber. This process does not require fuel for heating the ovens other than the non-condensible gases obtained by the process. The quantity of these gases is sufficient so that some is available for power purposes beside that used for heating the ovens. The process does not require skilled labor and it was stated to be economically suitable to this country on that account.

PEAT FUEL.—In a paper on this subject Mr. F. J. Bulack stated that peat made into briquettes by the wet process at Factory No. 1, of the Commercial Artificial Fuel Co., in Michigan (containing 1% moisture, 7% ash and of a thermal value of 10,000 B.T.U.) had been demonstrated to be adapted to steam boilers and residence heaters, cook stoves fitted with coal grates, lime kilns, etc. It could be furnished for furnaces, boilers, and residences at about $3.50 to $4.50 per ton. Under boilers practical experience had shown that peat fuel with 15 to 18% moisture gave better results than with less with briquettes broken into pieces to pass through a 2½-in. screen. For residence furnaces something less than 15% moisture with pieces of fuel some 2 × 4 × 6 ins., had been found successful. By careful banking fire had been held for 48 hours. A peat gas from Mexican peat, tested by the author, yielded (average of 6 samples) 24.45 cu. ft. per dry ton of fuel. The maximum of these tests had given 35.33 cu. ft. The average ash content of this peat was 24.46 and the B.T.U. value was 345.

Mr. W. G. Milne, of W. A. Milne & Sons, Hamilton, Ontario, read a paper entitled "Peat as a Steam Fuel." In this the author divided peat for fuel into cut, machined, briquetted and dust. It was stated that when the moisture content is as high as 35% under some conditions, the fuel may burn to a high temperature. With grates no bad results had been noted with a fuel containing up to 16%. The use of peat dust had been tried by the author and he believed it to be the best and cheapest fuel for steam engine boilers under many circumstances. At the plant whose process had been outlined, in the paper by Dr. P. McWilliams, peat dust was drawn from the stock which was passing to the briquetting machine, passed through a grinder and blown into the firebox with a proper supply of air. The average moisture content was 15%. It was ground in a grain grinder as that was the only machine obtainable. The ground material all passed through a No. 16 screen, 24% through a No. 20. The condition of the fire was regulated by the speed of the blower and grinder. It was found that 100 lbs. would run the 67-HP. steam engine outfit, of the peat plant, 22 min., which was a rate of about 4.2 lbs. per HP.-hr. At a cost of $2.50 per ton the cost of fuel per HP.-year for 10-hr. power would amount to about $13. The author stated that ground peat had been found successful in a local cement plant in place of powdered coal.

A NOVEL SOLUTION of the street railway congestion problem is reported from Washington, D. C. An organization is said to have been formed among post-office employees, whose members agreed to go to and from their work on roller skates.

NOTES FROM ENGINEERING SCHOOLS.

UNIVERSITY OF MICHIGAN.—The Board of Regents has established a chair of applied electrical engineering to which Mr. C. F. Muralt, M. Am. Inst. E. E., of the firm of Murphy & Co., Consulting Engineers, New York City, has been appointed.

COLUMBIA UNIVERSITY.—In connection with the other educational institutions about New York City, Columbia University will offer night courses adapted to the needs of technical and professional workers. During 1907-8 20 such courses will be offered. These include Applied Mechanics, Architecture, Electricity, Industrial Chemistry, Mathematics, Surveying and Structural Engineering and Fine Arts. The work begins on October 28, and continues 25 weeks. Fuller descriptions of these courses may be obtained from Fred. D. Sykes, Director of Extension Teaching, Columbia University.

CORNELL UNIVERSITY.—In his annual report to the Board of Trustees, Pres. Schurman recommends as advisable the addition of one year to the regular engineering course of four years, the entire five years to be required before the awarding of the degree of M. E. or C. E. There is at present at Cornell a six-year course available, in which the student devotes the electives of his first four years to the broader general science subjects of the engineering course and to the humanities, while the last two years are given over entirely to the engineering subjects. Under this course the degree of A. B. is granted at the end of four years and C. E. or M. E. at the end of six years. It has been found, however, that few students have the time or money to avail themselves of the six-year course and to avoid the enforced narrowness of the purely engineering courses, a narrowness that is growing with the number of new and increased subjects taught in the technical branches, the president recommends this preliminary compulsory year in which the student devotes the major portion of his time to the broader and more humanizing subjects of history, literature and language with minors in the elementary branches of pure science which now are taken up in the first term of the technical course. This recommendation must be passed on by the Board of Trustees before becoming a rule of the university.

BREAKFAST IN A CEMENT MILL.

By HERBERT A. RICE, Assoc. M. Am. Soc. C. E.*

The Crusher shook his head and growled,
And crunched his stony meal;
The Motor, too, "picked up" and howled
Like an electric seal.

The Dryer, wakened from his sleep,
Turned over with a sigh
And glumly muttered, low and deep,
"This breakfast is too dry!"

The Screw Conveyor, waiter-like,
Bethought his duties ended
When Griffin Mill—adown the pike—
Had had his crop distended.

The Bin, when loaded to the brim,
"Wished he were feeling stronger."
The prudent Tube Mills cautioned him
To chew his food much longer.

Sir Elevator, tall and vain,
Attempted something witty;
Declared it gave him quite a pain,
His breakfast was so gritty.

The Kiln—the lord of all the plant—
With fiery breath and eye,
Consumed with angry roar and rant
The food from Coal Bin high.

The Cooler—soothing soul is he—
More calmly takes his food.
He wonders much how Kiln can be
So impolite and rude.

Old Ball Mill wakes, and deep he groans:
His stomach's full of sinkers;
Then, grumbling low in sullen tones,
Attacks his meal of clinkers.

Then Finish Tube Mill, quite content,
Without the least grimace,
Chews up his food of fine cement
And runs a merry race.

Last, Storage Bin, with greedy maw,
Eats like a hungry pig;
His manners are exceeding raw
And his stomach's very big.

This is the story as I heard
All the machinery tell.
If you're inclined to doubt my word,
Go you and listen well.

*Professor, Department of Civil Engineering, University of Kansas, Lawrence, Kan.

THE RED STAR LINER "FINLAND" struck the Dover breakwater on the night of Oct. 28, while apparently attempting to make port without the usual assistance from tugs. Her bows were stove in badly by the impact, some damage being caused below the water line; and considerable panic prevailed among those on board. The "Finland" was built in Philadelphia by the Cramps in 1902, and is 578 ft. long, with a gross tonnage of 12,760.

The "Kaiser Wilhelm der Grosse," of the North German Lloyd line, broke her rudder while eastbound off the Newfoundland Banks on Oct. 25. She reached Plymouth on the evening of Oct. 29, having been steered the rest of the way across by means of her propellers—a distance of 1,750 miles. This is regarded as one of the most remarkable feats of seamanship in the history of big steamers; Capt. Polack remained on the bridge continuously after the rudder broke, having no sleep in over 100 hours. Particularly heavy weather after the mishap, amounting to a hurricane, made it necessary to pour oil on the water to lessen the effect of the waves.

THE STEAMSHIP "EMPRESS OF CHINA" of the Canadian Pacific Ry. Co. sank on Oct. 23 at her pier at Vancouver, B. C. Apparently her sea-cocks must have been open, though for what reason no information is available. The vessel was taking cargo when she sank and keeled over on her port side so that the main deck lay at an angle of about 45°, with her engines and dynamos under water. She was booked to sail to-day.

THE WEEK'S LIST OF RAILWAY WRECKS is again headed by an European disaster. On the Metropolitan Underground Ry., of London, which, it is said, has carried since its opening 300,000,000,000 people without a fatal accident, three persons were killed and a dozen or more injured in a rear-end collision on Oct. 26, at the West Hampton station. The wreck occurred during the morning rush hour and both trains carried heavy loads of suburbanites. The rear train, according to reports, ran in a fog past the signals which were set against it, striking the train standing at the station; the heavy locomotive smashed its way into the rear car of the standing train, demolishing it and killing or injuring most of its occupants. This is the first accident of the kind since the road was electrified, a system of electric signals being installed at that time.

A wreck on the Wabash R. R., near Mexico, Mo., on Oct. 26, killed the engineer and injured six other persons. The St. Paul train for St. Louis left the rails—a defective rail being the reported cause—and went into the ditch.

A passenger train on the Missouri, Kansas & Texas Ry. collided at high speed with a light engine near Dallas, on Oct. 27. The fireman of the passenger train was killed and 50 passengers were injured, a number seriously. The passenger engineer, according to report, said that his watch was 36 mins. slow.

The Jefferson St. bridge over the Cuyahoga River at Cleveland gave way under a loaded ore train on Oct. 21, and the train crew were thrown in the river. The conductor was drowned.

On the Chicago & Erie R. R., near Leiter's Ford, Ind., a passenger train overtook and collided with the rear part of a broken-in-two freight train. The passenger engineer was killed and 20 passengers injured.

A work train on the Schoodic R. R., being built near East Millinocket, Me., struck a washed-out trestle on Oct. 26, and was overturned and submerged, and five Italians are said to have been killed or drowned.

THE EXPLOSION OF THREE BOILERS on Oct. 23, at the Kimberly mine of the Sunday Creek Coal Co., Nelsonville, Ohio, killed three men and seriously injured two. Defective tubes are reported as the cause of the accident.

THE "MAURETANIA," SISTER SHIP OF THE "Lusitania," left the River Tyne on Oct. 22 for a trip around North Britain to Liverpool. On this short voyage she was not pushed in the matter of speed, making, according to cabled reports, no better than 21 knots. On her secret builders' trial she developed, according to figures cabled as authoritative by the London correspondent of the New York "Times" on Oct. 26, a speed of 25.05 knots—and this with her plates fouled by 12 months in the water of the River Tyne. Rivalry runs high between her builders on the Tyne and those of the "Lusitania" on the Clyde; expectations seem to be that the "Mauretania" will surpass the "Lusitania" when the former goes formally into commission.

The "Lusitania" arrived at Queenstown on the evening of Oct. 24 on her second east-bound voyage, having covered the distance from Sandy Hook to Daunt's Rock in 4 days, 22 hrs. and 53 mins. This was 5 hrs. and 26 mins. better than the time made on her first eastward voyage, in spite of rough weather which obliged her navigators to slow down the engines at times. Her best daily run on this voyage was 570 knots and her average hourly speed for the entire distance, 23.61 knots. It should be noted that the vessel was traveling against the sun and that her days were 23 hours in length.

A SERIOUS EARTHQUAKE has been reported from Calabria, Italy. Later despatches in regard to it place the estimated number of fatalities at 600. The usual heavy storms which accompany such phenomena have caused intense misery and suffering among the victims. Press despatches of Oct. 24 state that the oscillation was so violent that the needle of the seismograph in the observatory at Calabria was broken. A first shock of great force was reported, followed by two others of longer duration. Two villages are said to have been entirely destroyed and many houses in other villages reduced to masses of ruins.

The community has hardly recovered from the effects of the earthquake of 1905. Only on Oct. 22 the Italian Minister of Finance opened two entirely new villages in Calabria, which had been built by the Relief Committee of Milan for the victims of the earthquake of 1905. These villages seem to have withstood the shocks. Scientists of the University of Naples say that the earthquake of 1905 was preceded by eruptions of Stromboli and Ætna, which suddenly ceased and were immediately followed by the Calabrian earthquake of that year. Mt. Vesuvius, they are further quoted as stating, was most active until a week prior to this earthquake, but since then the volcano has emitted no smoke.

FREIGHT TRAFFIC ON THE MAIN LINE OF THE Pennsylvania R. R. is heavier this fall than at any previous time. During the first 27 days of October, 175,182 loaded cars passed Lewistown Junction—an increase of 10% over the corresponding period in 1906. On Saturday, Oct. 26, 7,854 loaded cars were moved, and the daily average for the week was 6,847. The heavy traffic, and consequent demands upon the shops for repart of a broken-in-two freight train. The passenger the working force in the Altoona shops.

THE WASHINGTON, D. C., UNION RAILWAY TERminal was opened for the first regular train on Oct. 27. This station, which is to be used by all steam railways entering the city, is the key to the large railway system which has been in process of construction around the Capital for the last five years. Heretofore the various railways have entered the city, on grade, into two stations, remarkable principally because of their exceptional dirtiness and ugliness. The new construction has removed all grade crossings by bridges, fills and a tunnel under Capitol Hill, and has brought all of the traffic on 33 parallel tracks, into the Union Terminal, situated some four blocks north of the U. S. Capitol. The terminal building is the largest for that purpose in the world, though the designs for the new Pennsylvania and New York Central stations call for larger structures. In addition to its great size, the architect, Mr. D. H. Burnham, has paid especial attention to the artistic features of the exterior and has produced a fitting companion to the monumental public buildings of Washington. The city appropriated a large amount of money for land condemnation for a broad and spacious plaza in which the terminal is built. At present only the bare necessities of the terminal are completed and only those trains which have used the B. & O. depot will come into the new station. It is expected that it will be a year before the work is entirely completed and the old system abolished.

THE OPERATION OF LARGE GAS ENGINES on producer gas at the Johannesburg Electric Power Station, Johannesburg, South Africa, is commented on in "Electrical Engineering" of London, issue of Oct. 10, by the Cape Town correspondent of that journal. Some of these remarks are appended:

> The choice of gas-engine plant proved most unfortunate, and the result of a notable and interesting enterprise will be regretted by every impartial engineer. It will be remembered that the plant installed originally included five gas engines each of 2,000 HP., at 100 r. p. m., and three each of 1,000 HP. at 125 r. p. m., a total of 13,000 HP. These were supplied with producer gas, and gas-holders were installed; these gas-holders were not designed to act as reservoirs, their capacity being simply sufficient to keep one engine running for 20 minutes at full load. This was regarded as sufficient storage, as additional producers could be started as required. The engines were started by compressed air with electric spark ignition. An explosion took place every revolution, the initial pressure being 350 lbs. and the compression 150 lbs., but this was to have been increased. Each engine had two cylinders, into which the gas was pumped. The governors acted on by-pass valves, which returned the surplus gas to the holders. The number of explosions was independent of the load, the mixture being varied as required. One of the chief sources of trouble was the choking of the producer gas plant with tar from the condensation of the hot gas. The engine ports required cleaning every two months for the same reason; this was a troublesome job owing to the mechanical complications in connection with the cold water circulation through the pistons as well as round the cylinders. The smaller engines knocked badly on light load. Gas engines were adopted as promising a greater economy than steam engines. The estimated saving in this respect was $75,000 per annum, and it was anticipated that using Middleburg coal at about $2.85 per ton delivered, the credit from the sale of the tar for which there is a steady local demand would have brought the net cost down to about $1.55 per ton. In addition to the tar trouble, the effects on the staff of an escape of gas, even though no very objectionable odor was evident, were found to be serious, necessitating medical attention in many cases. The electrical plant consisted of two 180-KW. alternators of 3,300 volts at 50 cycles, three direct-current machines of 1,300 KW., and three of 650 KW., these latter being available for either lighting or traction. The distribution system in the town is three-wire, 460 volts between outers, 230-volt lamps, with balancers on the middle wire. The suburbs are supplied with two-phase current at 200 volts. Messrs Reunert and Lenz are the contractors for the temporary plant.

AN ELECTRICAL HOISTING EQUIPMENT of considerable interest was recently built by the General Electric Co. for the Kendall Gold Mining Co. of Kendall, Mont. A description of the equipment was given in the General Electric "Review" for September, 1907. The equipment was designed to raise 2,000 lbs. of ore from a depth of 1,000 ft. every 103 seconds when operating two drums, and every 170 seconds when but one drum was in operation. The shaft has two compartments and is vertical. Two cylindrical drums are used, provided with the usual clutches for individual and combined operation—a drum for each compartment. The rope is 1 in. in diameter and weighs 1.6 lbs. per ft., the hoisting speed being 1,000 ft. per min.

The feature of special interest about the equipment is one which was provided to overcome the effect on the somewhat limited generating plant from large rushes of current at starting, which tended to produce undesirable voltage fluctuations in the system. A fly-wheel motor-generator set is provided, which consists of an induction motor and a direct-current generator with a heavy solid-cast fly-wheel swung between them, and a direct-current exciter overhung at one end of the set. The system of control is arranged to brake the load electrically in a manner which gives complete control over the retardation of the moving parts of the hoist, at the same time returning a considerable portion of their kinetic energy to the fly-wheel. The hoist equipment consists of a shunt-wound direct-current motor driving the drums by gearing, and receiving its power from the motor-generator set previously described. The small overhung exciter on the motor-generator shaft excites the fields of the direct-current generator and of the hoisting motor. The fly-wheel is a steel casting machined all over, weighing about 12,000 lbs. and operated at a peripheral speed of about 18,000 ft. per min. In order to obtain the value of the fly-wheel in alternately storing and surrendering energy, the induction motor is arranged for variable-speed operation, changes in speed being automatically controlled by the variation of the main-line current, which is led through a small three-phase regulating motor operating a water rheostat in series with the secondary winding of the motor. The torque produced by the full-load value of the main-line current in the windings of the regulating motor is balanced by the weight of the moving parts of the water rheostat, so that there is no change in the resistance in series with the rotor winding of the motor-generator set as long as the motor takes full-load current. If it should demand more or less current, there is an immediate movement of the water rheostat, which accelerates or retards the speed of the motor-generator set so that the induction motor again takes full load and the movement of the water rheostat is stopped. The equipment has been installed for several months and is reported to be giving perfect satisfaction to the users.

THE REPUBLIC OF MEXICO, according to a statement published recently by the Mexican Department of Fomento (similar to our own Department of the Interior), contains more than 1,000 mines operated mainly for copper production. These are located in the different states as follows: Jalisco, 302; Sonora, 234; Michoacan, 95; Lower California, 65; Chihuahua, 53, and Durango, 51. In proportion of production tonnage, however, Sonora leads, while Lower California is second; the mines in the State of Jalisco are small producers.

SEWERAGE AND SEWAGE PURIFICATION WORK at Baltimore has progressed so rapidly during the first year's operations under the Sewerage Commission that 23 contracts, involving the expenditure of nearly $3,000,000 have been let. Some 15½ miles of sewers have been completed and the sewage testing station has been built. One of the contracts provides for leveling the 429 acres of disposal area at Back River. Mr. Calvin W. Hendrick is Chief Engineer of the Sewerage Commission.

AN ELECTRICALLY-DRIVEN CENTRIFUGAL PUMP recently installed at the Lakewood pumping station of the Duluth water-works has a capacity of 12,000,000 gals. per 24 hours. It is a Morris centrifugal pump, less than 7 ft. diameter, and the guarantee provides that the combined efficiency of transformer, motor and pump, shall exceed 70%. The discharge pipe line is equipped with a 20-in. Venturi meter. Electricity is furnished at a price per million gallons pumped: $6.50 per million gals. up to 6,000,000 gals. per day, and decreasing 10 cts.

with each additional million up to 15,000,000 gals., when the fixed rate of $5.50 will prevail. The water is pumped for an elevation of 290 ft. to a reservoir, from which a present daily consumption of about 6,000,000 gals. is distributed. The pump is completely installed and ready for a preliminary test. The contract was awarded to the General Electric Co. for the whole equipment, including the pump, transformer, motor, switchboard, induction motor panel, incoming line and transformer panel, lightning arrester equipment, and disconnecting switches. Mr. L. N. Case is Manager of the Water and Light Commission of Duluth, Minn.

PERSONALS.

Mr. E. M. Peden has been appointed Superintendent of Motive Power of the Santa Fe Central Ry., with headquarters at Estancia, N. Mex.

Mr. Chas. R. Case, Acting Superintendent of Streets and Sewers of Seattle, has tendered his resignation. Mr. M. T. Maloney is to succeed him.

Mr. H. F. Weeden, Port Superintendent of the Tehuantepec National Ry., at Salina Cruz, Mex., has resigned. Mr. R. W. Filler has been appointed to fill the vacancy.

Mr. J. N. Wilber, Master Mechanic of the Chicago, Burlington & Quincy Ry., at Hannibal, Mo., has resigned after 50 years of service. The resignation will take effect on Jan. 1, 1908.

Mr. John H. Barrett has resigned as Engineer of Construction of the Pittsburg & Butler (Pa.) Street Ry. Co., and has become Vice-President and General Manager of the Jas. B. Sipe Mining Co.

Mr. W. W. Wallace has resigned as General Manager of the Wm. J. Oliver Mfg. Co., of Knoxville, Tenn., makers of mining and contractors' equipment. The office of General Manager is abolished.

Mr. I. B. Richards has been appointed Acting General Superintendent of the Yellowstone, Montana and Rocky Mountain divisions of the Northern Pacific Ry., with headquarters at Livingston, Mont.

Mr. J. M. Plummer, Roadmaster of the Missouri Pacific Ry., at Bastrop, La., has been appointed Roadmaster of the New Orleans & Northwestern division, with office at Ferriday, La., to succeed Mr. I. D. Roan, resigned.

Mr. W. D. Taylor, M. Am. Soc. C. E., Chief Engineer of the Chicago & Alton Ry., has had his jurisdiction extended over the Toledo, St. Louis & Western Ry., which is now practically consolidated with the former road.

Mr. D. H. Thomas, General Superintendent of the Thomas Iron Co., of Hokendauqua, Pa., has resigned. Mr. Samuel R. Thomas, his brother, succeeds him as Superintendent of the company's Ironton railroad, which position he also occupied.

Mr. Felix F. Wiener has resigned as Vice-President and Treasurer of Henry Pels & Co., importers and manufacturers of punching and shearing machines, and has become a partner in the International Electric & Engineering Co., of 150 Nassau St., New York City.

Dr. Samuel Fortier, Irrigation Engineer at Berkeley, Cal., in the office of Experiment Stations, U. S. Department of Agriculture, has been promoted to the position of Chief of Irrigation Investigations. Mr. C. G. Elliott, Chief Drainage Engineer, has been made Chief of Drainage Investigations.

Mr. L. D. Smith has been appointed Assistant to the President of the Lehigh Valley R. R., with offices at 143 Liberty St., New York City, and 228 South Third St., Philadelphia. Mr. F. L. Blendinger has been appointed Assistant to the First Vice-President, with offices at 143 Liberty St., New York City.

Prof. W. F. M. Goss, M. Am. Soc. M. E., has just returned from Europe, where he has spent the past summer making a study of foreign practice in the use of locomotive superheaters. He will at once take up his new duties as Dean of the College of Engineering of the University of Illinois, at Champaign, Ill.

Mr. Bion J. Arnold, M. Am. Soc. C. E., and Past President Am. Inst. E. E., has been engaged as Consulting Engineer by the Public Service Commission of the State of New York, First District, to study and report upon transportation conditions—particularly in the matter of the construction and operation of the present New York subway.

Mr. George S. Rice, M. Am. Soc. C. E., has resigned as Chief Engineer of the Public Service Commission of New York City, the resignation to take effect on Dec. 1. Mr. Henry B. Seaman, M. Am. Soc. C. E., has been appointed as Mr. Rice's successor. Mr. Rice will remain in the service of the Commission, as Assistant Engineer in charge of construction.

Mr. Hiram J. Slifer, M. Am. Soc. C. E., appointed to succeed Mr. W. G. Bierd as General Manager and Assistant to the President of the Panama R. R., arrived at Cristobal on Oct. 10 and at once took up his duties. Mr. Slifer only recently resigned as steam railway expert for J. G. White & Co., as we noted here on Sept. 5, to open an office as a consulting engineer in New York City.

Mr. Percival Roberts, Jr., has been elected a director of the Pennsylvania R. R., to succeed the late Alexander M. Fox. Mr. Roberts is a well-known engineer, and is a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers (of which he was a former Vice-President) and the American Institute of Mining Engineers. He is also a director of the Philadelphia National Bank and of the Land Title & Trust Co.

Messrs. C. F. Chism, E. J. Pickwick, W. H. Van Wie, T. R. Ripley, F. J. Wagner, C. A. Ingersoll, T. J. Morrison, O. F. Bellows, F. C. Davis, E. Styring, J. A. O'Connor, C. H. McCullough and Herbert Spence, Jun. Am. Soc. C. E., have been appointed as resident engineers by State Engineer Skene, of New York. The appointees have all been in the State Engineer's department, and nearly all reside in Albany. Increase in the volume of work in the department is the reason for this considerable increase in the number of resident engineers.

Mr. Clyde T. Griswold, E. M., has just entered upon his duties as Professor of Mining and Metallurgy at Colorado College. He succeeds Dr. Thomas T. Read, who accepted the position of Professor of Metallurgy at the Imperial University in Tientsin, China. Prof. Griswold is a graduate of Amherst College and of Columbia University, and was connected for some time with the Canadian Copper Co., as Superintendent of their Crean Hill mine at Victoria Mine, Ontario. Just before coming to Colorado College Mr. Griswold was acting as Superintendent of Construction for the same company on their new smelter rearrangements and additions, which were estimated to cost $1,000,000 when completed.

Mr. Richard T. Laffin, Vice-President and General Manager of the Manila Electric R. R. & Light Co., has resigned, having completed the task of establishing the operating organization of the property on a sound earning basis. The management is now assumed by Mr. C. B. Graves, who has been Mr. Laffin's right-hand man since the property was placed in operation three years ago, officiating as Manager of the Lighting and Power Department. Mr. Laffin is still interested financially in the Manila properties, and resigns to take the management of another group of public utility properties in which J. G. White & Co., Inc., are largely interested. Mr. Graves has had extended experience in the management of electrical properties in the tropics. At one time, before becoming connected with the Manila Electric R. R. & Light Co., he was Electrical Engineer and Assistant Manager of the extensive properties of the San Paulo Tramway, Light & Power Co., San Paulo, Brazil.

Mr. Orville H. Ensign, M. Am. Inst. E. E., Consulting Engineer in the U. S. Reclamation Service in charge of electrical and pumping work on the Pacific Coast, has been appointed to the Chair of Electrical Engineering at the University of Wisconsin, made vacant when Prof. Dugald C. Jackson resigned to go to the Massachusetts Institute of Technology. Mr. Ensign has for 20 years been identified with large engineering undertakings, and is well known to the profession. After graduating from Cornell University he served his apprenticeship with the Schenectady Locomotive Works; he was then placed in charge of power plant construction for the New York Edison Co., from 1887 to 1889. Thereafter he was associated with the General Electric Co., at Schenectady, until 1893, since which time his activities have been on the Pacific Coast. Mr. Ensign became associated with the Reclamation Service in 1904, and in accepting the Chair of Electrical Engineering at the University of Wisconsin he still retains his connection with the Service.

Obituary.

Thomas Bell, President of the New York Sand & Facing Co., of Brooklyn, died at Catskill, N. Y., on Oct. 29, in his 80th year. He owned large coal, ice and molding sand interests. In 1850 he served on the U. S. S. "Massachusetts," employed in surveying the coast of California from San Diego to Golden Gate.

Charles Henry Deere, head of the firm of Deere & Co., plow manufacturers at Moline, Ill., died at Chicago on Oct. 29. He was born at Hancock, Vt., on March 28, 1837, and was the son of John Deere, the pioneer plow manufacturer. The works at Moline were founded in 1848. Mr. Deere was President of the Moline Water Co.

Charles Ezra Hequembourg, M. Am. Soc. C. E., former Mayor of Dunkirk, N. Y., died on Oct. 17, at his Dunkirk home. Mr. Hequembourg was born in 1845; and since the Civil War, in which he served, he has been engaged variously as a civil engineer, contractor, and oil and gas operator. The water works at Dunkirk, and at Hyde Park—near Chicago—were built by him. His greatest piece of work was the building, in 1888, of a pipe line from the Indiana gas fields to Chicago, at that time the longest system of its kind in the world. A wife and five children survive him.

John Howard Clark, M. Am. Soc. C. E., died of consumption on Oct. 13, at Georgetown, Cal. Mr. Clark was born on July 27, 1864, at Leesville, Ohio, and began the practice of civil engineering in 1887; after graduating from Harlem Springs College with the degree of Bachelor of Science, he was employed successively in county surveying, upon the construction of the Columbus Connecting & Terminal Ry. at Columbus, Ohio, and the Pittsburg & Western Ry. at Londonville, Ohio, and by the Boston & Maine R. R. at Northampton, Mass., Portsmouth, N. H., and Malden, Mass. Mr. Clark had charge in the field of double tracking the Westerly loop of the Boston, Revere Beach & Lynn R. R. and was later engaged in the construction of the Southern Railway R. R. at Bristol, Va.-Tenn.

ENGINEERING SOCIETIES.

COMING MEETINGS.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION.
Nov. 11-14. Twenty-fifth annual convention at Chicago. Secy., W. E. Emery, C. & A. Ry., Kansas City, Mo.

AMERICAN MINING CONGRESS.
Nov. 11-16. Tenth annual convention at Joplin, Mo. Secy., J. F. Calibreath, Jr., Denver.

AMERICAN CIVIC ASSOCIATION.
NATIONAL MUNICIPAL LEAGUE.
Nov. 19-21. Joint convention at Providence, R. I. Secy., Clinton R. Woodruff, North American Building, Philadelphia.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 21-22. Fifteenth general meeting at New York City. Secy., W. J. Baxter, 29 West 39th St., New York City.

SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 5-7. Convention at Chicago. Secy., C. R. Richards, Columbia University, New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—At a meeting to be held in the auditorium of the Engineering Societies Bldg. on Nov. 8, at 8:15 p. m., Mr. Albert H. Armstrong, of the General Electric Co., Schenectady, will present a paper on "Comparative Performance of Steam and Electric Locomotives."

SANITARY OFFICERS OF THE STATE OF NEW YORK.—The seventh annual conference was held at Convention Hall, Buffalo, on Oct. 16, 17 and 18. After the opening address by Eugene H. Porter, M. D., State Commissioner of Health, Gov. Hughes addressed the conference. Papers on the program were as follows: "The Dissemination and Control of Tuberculosis as Illustrated in the Bovine Species," Veranus A. Moore, M. D.; "The Early Diagnosis and Treatment of Tuberculosis," John H. Pryor, M. D.; "The Social Aspects of Tuberculosis," Edw. Devine, M. D.; "Sanitary Inspection of Wells and Their Surroundings," L. M. Wachter; "Sewage Disposal for Institutions and Small Communities," Theo. Horton, C. E.; "The Laws Relating to the Pollution of Streams," A. H. Seymour; "Labor Legislation in Its Relation to Public Health," Adna F. Weber; "The Law Relating to Nuisances," Senator W. J. Tully; "Practical Points on Quarantine," J. T. Wheeler, M. D.; "Detection of Communicable Diseases," H. E. Schmid, M. D.

The seventh session was given over to the pure milk problem; modes of ensuring it were treated as follows: By Inspection of Dairies and Farms—by Thomas Darlington, M. D.; By the Permit and License System—by Ernst Wende, M. D.; By the "Telltale" Milk Register—by Henry R. Hopkins, M. D.; By Educational Measures—by Geo. W. Goler, M. D.; By the Use of the Score-Card System—by Ellis M. Santee, M. D. Mr. Alec. H. Seymour is Secretary of the State Department of Health.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—The program has been issued for the fifteenth general meeting, to be held at the Engineering Societies Building, New York City, Nov. 21 and 22. Sessions will begin at 10 a. m. each day. For the first day the following list of papers has been arranged: "An Experimental Investigation of Stream Lines Around Ships' Models," by Naval Constructor D. W. Taylor, U. S. N.; "Some Experiments Upon the Effect of Longitudinal Distribution of Displacement," by Prof. H. C. Sadler; "Further Tactical Considerations of Warship Design," by Com. A. P. Niblack, U. S. N.; "Submarines of Battleship Design," by Mason S. Chase; "Motor Boats for Naval Service," by Naval Constructor L. S. Adams, U. S. N.; "High-Speed Motor Boats for Pleasure Use," by H. R. Sutphen; and "Some Observations on Motor-Propelled Vessels and Notes on the Bermuda Race," by W. B. Stearns.

For the second day there are scheduled "Two New Revenue Cutters for Special Purposes," by Capt. C. A. McAllister, U. S. R. C. S.; "Tests on the S. S. 'Governor Cobb'," by Prof. W. S. Leland; "Appliances for Manipulating Lifeboats on Seagoing Vessels," by Axel Welin; "The Transportation of Refrigerated Meat to Panama," by Roland Allwork; "Two Instances of Unusual Repairs to Vessels," by Asst. Naval Constructor W. B. Ferguson, U. S. N.; "Wooden Sailing Vessels (with Particular Reference to Those Built Previous to the Civil War)," by B. B. Crowninshield; and "Some Early History Regarding the Double-Turreted Monitor 'Miantonomoh' and Her Class," by W. T. Powell.

A banquet at Delmonicos will conclude the meeting, at 7 p. m. on Oct. 22.